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THE AGRICULTURAL COLLEGE, COIMBATORE.

Although the work of the abovenamed College has been in progress for more than a year, the formal opening ceremony only took place on the 14th of July last. A full account of the proceedings on this occasion will be found on another page, together with a description of the buildings and of the origin of the institution itself—both taken from the "Indian Patriot" for July 15th, 1909. We have already reprinted in the *Tropical Agriculturist* for June an article from the Madras Agricultural Calendar for 1909, in which the objects and work of the College are dealt with by the Principal, Mr. C. J. W. Shepperson.

From the accounts received it is evident that the Agricultural Department of Madras proposes to deal with the problem of disseminating agricultural knowledge on a liberal and sufficient scale. For this purpose a farm of 450 acres in extent is attached to the block of buildings said to have cost eight lakhs of rupees. Additions are being made to the staff of experts, and a suitable curriculum has been drawn up. Similar developments are taking place in other parts of India, and it is evident that Ceylon—which showed the way to India in the matter of plant sanitation and insurance against disease—is being temporarily left behind so far as Agricultural education is concerned.

The course of training for the Agricultural Diploma at Coimbatore College is to extend over three years, and in every subject theoretical and practical training are combined. The first year's courses are mainly confined to an elementary study of the different pure sciences upon which modern agriculture is based, whilst in the second and third years, practical and theoretical agriculture, entomology, agricultural engineering, veterinary science and other subjects of practical utility are to be taken up.

The Coimbatore Agricultural College may thus shortly be expected to turn out twenty students annually, duly trained in all that appertains to modern scientific agriculture as applied to the products of Southern India. Some of the diplomatists will doubtless come to occupy inspectorships and other posts comprised within the general scheme of Government supervision, whilst others may employ the information they have acquired in farming on their own account. It cannot be doubted that the knowledge thus disseminated will have an important influence in promoting the prosperity of a purely agricultural community.

The Institute provides, however, not only for education, but also for research.

The staff at Coimbatore will ultimately include a botanist, an agricultural chemist, a mycologist and an entomologist, in addition to the Principal who is also directly in charge of the experimental farm. There are few subjects in which research can be more profitably combined with research than is the case with agriculture. Modern methods, already proved profitable in connection with the established cultivations of Europe and America, require to be carefully tested in their application to the products of a different zone and climate; and it is particularly desirable that the teachers of agriculture should themselves have ample opportunities of carrying out such tests; whilst it is little more than a truism to say that the pure sciences are best taught by men who are themselves engaged in extending the boundaries of knowledge.

In the above we are concerned solely with the interests of education, since it would carry us too far if we attempted to deal with Coimbatore as an institution of research. From an educational point of view we consider that Ceylon has every reason to be envious of her neighbour.

R. H. L.

GUMS, RESINS, SAPS AND EXUDATIONS.

MANURING OF RUBBER.

By GEORGE A. BOWIE, M.A., B.SC.

(From the *India Rubber Journal*, Vol. XXXVII., No. 8, April, 1909.)

The query as to how far the low vitality and yielding power of many rubber plantations is due to the want of proper fertility can only be satisfactorily answered after carrying out suitable manuring experiments on the soils in question. Although this is so, there can be little doubt from the results of experiments already conducted, combined with a kowledge of the principles of plant nutrition, that in many cases the unsatisfactory state of affairs is exclusively due to continued neglect in manuring, or failure to restore to the soil the chief elements of plant food, viz., nitrogen, potash, phosphoric acid and lime. It is quite true that in the cultivation of rubber trees comparatively little in the way of these ingredients is permanently withdrawn from the soil, but the small amount that is removed, chiefly in the latex and macerated bark, must be returned if the plants are to maintain their normal vigour and prolifity. No matter how rich the soil may be at first, it is bound to become exhausted, sooner or later, by constant cultivation, and it should not be forgotten that this stage is reached earlier when tea or any other economic crop, as is frequently the case, is grown on the same ground. The question then arises—what kind of manuring should be adopted, or, in other words, in what proportions and forms should the abovementioned ingredients be applied artificially to the soil in order to suit the needs of the trees.

In the first place it must be observed that a heavy application of nitrogen is apt to be followed by disappointing results. An excess of this ingredient has often the effect of stimulating the growth of the foliage to such an extent that the trunk becomes too weak to support it, and the whole tree is bent over by the force of the wind. To prevent this and to obtain uniform growth, it is strongly recommended to restrict the quantity of nitrogen within moderate limits, and to supplement it with phosphates and specially with potash which, according to the results of numerous tests, exerts a particularly beneficial influence on the wood of the tree.

The relation between the amounts of nitrogen and potash applied has, no doubt, a great deal to do with success in the manuring of rubber trees. This is well brought out in an experiment on Hevea, conducted by Mr. R. M. Eckert, Vincit, Ruanwella, Ceylon. By the use of a manurial mixture containing 6 per cent. of nitrogen and 5 per cent. of potash, the foliage was developed quite out of proportion to the wood, with the result that the trees were broken down by the wind. A mixture containing 4 per cent. nitrogen and 15 per cent. potash, produced, however, quite a different effect, the trees presenting a vigorous appearance and showing uniform growth. The firm and solid structure of their trunks was noticeable.

The benefits accruing from the judicious manuring of rubber are further illustrated by the results of a carefully carried out experiment at Deli-Moeda, East Coast of Sumatra. Commencing in October, 1906, at which time the trees (Hevea) were two years ten months old, three plots of land were taken and

differently treated from a manurial point of view. At the end of two years the circumferences of the trees on the different plots were measured, at one yard above the ground, and the average for each plot was calculated. The results are shown as follows :—

Plots.	I. No Manure.	II. Completely Manured.	III. Manured without Potash.
Manuring per tree	—	2 lb. Pea-nut cake meal 12 oz. Double superphosphate 8 oz. muriate of Potash.	2 lb. Pea-nut Cake Meal 12 oz. Double Superphosphate
Average Circumference of Stems	9 inches	14 inches	12 inches

From the results of these and other experiments it is clear that potash may be made to play a very important part in the manuring of rubber. While this ingredient may be applied fairly abundantly with advantage, nitrogen may be used with a little more caution, in order to prevent a too luxuriant growth of foliage. Phosphoric acid is also, of course, indispensable, and although it may not benefit the wood to the same extent as potash, it serves like it to counteract the stimulating effect of nitrogen on the development of the foliage.

Bearing the foregoing facts in mind, we may lay down manurial mixtures of the following compositions, as being suitable for application under different conditions.

I.

The mixture is suitable for land rich in nitrogen and where there is a good leaf growth.

	Potash.	Phosphoric acid.	Nitrogen.
28 per cent. muriate of potash	14	—	—
25 ,, ,, superphosphate (18)	—	4·50	—
20 ,, ,, bonemeal (28) (1)	—	5·60	0·2
17 ,, ,, oilcake (6)	—	—	1·3
10 ,, ,, sulphate of ammonia	—	—	1·6
100 ,, ,, contains	14	10·1	3·1

400 to 300 lb. per acre to be applied.

II.

The second mixture is recommended for land which is in a poor condition with regard to its nitrogen content.

	Potash.	Phosphoric acid.	Nitrogen.
20 per cent. muriate of potash.	10	—	—
30 ,, ,, sulphate (18)	—	5·4	—
10 ,, ,, bonemeal (18½)	—	2·8	0·1
24 ,, ,, sulphate of ammonia	—	—	1·3
15 ,, ,, oilcake (6)	—	—	1·0
100 ,, ,, contains	10	8·2	6·0

400 to 700 lb. per acre to be applied.

As to the form in which the different plant foods should be supplied, no hard and fast rule can be laid down. This will depend on the climate, condition of the soil and also the kinds of artificial manures at one's disposal. In cases where the soil is deficient in organic matter, it will pay to employ as a source of nitrogen organic manures like fish guano, blood meal, oilcake, or as in the above case, for the purpose of producing a more rapid effect, a mixture of one or more of these substances with the inorganic manure, sulphate of ammonia.

Phosphoric acid can also be employed in various forms such as superphosphate, basic slag or bonemeal. While superphosphate is the most active of these manures, basic slag owing to its high lime content will be found valuable for soils deficient in this particular constituent. For land, which is lacking in organic matter, the use of bones is specially recommended.

Potash may be given in the form of muriate or sulphate of potash, but in many cases muriate seems to produce the better results in the dry climates.

These artificial manures can be sprinkled round the tree at a distance of 1 to 1½ feet from the stem for each year of the plant's growth and then very lightly forked into the soil. In order to prevent the manure from being washed away by the rain, however, a shallow trench may be cut round the tree, the manure forked therein and the surface soil then replaced.

Green-manuring or the system of growing and plough-into the land special leguminous crops might also be practised with advantage in the cultivation of rubber. In this way it is possible not only to add to the soil a large quantity of nitrogen from the atmosphere, but also to improve greatly the physical condition of the soil by means of the organic matter. An essential condition, however, to the success of green-manuring is that the leguminous crop in question must be well manured with potash and phosphates in order to ensure a rich production of green plant material. While green manuring will be found an excellent substitute for farmyard manure in cases where the latter is not available in sufficient quantity, its adoption must be regarded merely as supplementary to the use of artificials.

THE HARVESTING OF RUBBER IN HAWAII.

AN OUTLINE OF A CO-OPERATIVE EXPERIMENT.

BY RALPH S. HOSMER.

(From the *Hawaiian Forester and Agriculturist*, Vol. V., No. 12, December, 1908).

(Read at the Second Annual Meeting of the Hawaiian Rubber Growers' Association, Honolulu, Hawaii, November 18, 1908).

The object of this paper is briefly to describe the co-operative investigation recently undertaken by the Hawaii Experiment Station, the four rubber plantations at Nahiku, Maui, and the Division of Forestry of the Territorial Board of Agriculture and Forestry, to determine the best method of harvesting rubber in Hawaii.

By way of preface it may be recalled that in the summer of 1906 during an examination of the planted forest at Lihue, Kauai, made by Mr. C. S. Judd, then an agent of the Division of Forestry, there was brought to public attention the existence of two groves of Ceara rubber trees at Lihue and at Koloa, Kauai. As the trees were large enough be to tapped, these groves presented an opportunity for securing data as to methods of tapping and other facts and figures of value to the rubber industry. Accordingly, arrangements were at once made with both the Lihue and the Koloa Plantation Companies to permit systematic tapping tests to be undertaken. At first it was planned that the Division of Forestry should carry on the work, but as the Hawaii Experiment Station had a man available, which the Division of Forestry then did not, it was decided by the Board that it was best that the Experiment Station undertake the investigation. The field work was carried on by Mr. Q. Q. Bradford under the direction and supervision of Mr. Jared G. Smith, then Director of the Station, and much valuable information was collected. The results of the investigation have been published recenly as Bulletin No. 16 of the Hawaii Experiment Station—an important contribution to our knowledge of rubber in Hawaii.

Necessarily one investigator working with only limited means cannot be expected to answer all the questions that arise in so large a field as is the duty of a rubber production in Hawaii. At the beginning of this last summer it became apparent that further study on the ground was urgently required, particularly in the way of getting together exact figures on the cost of tapping the trees and attending to the other details necessary in transforming the latex into a marketable product.

To meet this need I proposed to Dr. E. V. Wilcox, the present Director of the Hawaii Experiment Station, soon after his arrival in Hawaii in July last, that such an investigation be undertaken jointly by his Station and by the Division Forestry; the Experiment Station to furnish the man to do the work, the Division of Forestry to supply the necessary funds for salary and expenses. This plan met with Dr. Wilcox's hearty approval, and later, with that of the representatives of the four rubber plantations of Nahiku.

From the start the experiment has been planned with special reference to securing figures that shall have direct practical bearing on the commercial development of the rubber industry. To attain this result there was kept constantly in mind in planning the tapping tests the conditions that the rubber plantation manager must face daily in actual practice. To this end it was arranged that there should first be tried only the simplest possible methods of tapping, such as any labourer of ordinary intelligence could learn to do, and that all refinements of process be at the start done away with. It was further provided that any given tapping test should be made on a large enough number of trees to be really representative, and that each such test should be continued as long as the size of the trees warranted. Another provision of the same order was that an accurate record be kept of the time of all labourers employed, in units of not less than one-half of an actual working day, the experiments being so planned as to keep the men busy during that time.

The two important points on which the success of the rubber industry in Hawaii turns are first, whether the trees yield latex in commercial quantities, and second, whether the latex can be collected and prepared for market at a profit. Until these questions are definitely answered the rubber industry must remain in the experimental stage. From the tappings of larger trees that have so far been made in Hawaii there is every reason to be sanguine over the flow of latex. The present investigation should go a long way toward throwing light on the cost of handling the product, for the figures that are being collected refer not alone to the tapping of the trees but include as well the several-

steps of collecting the rubber from the trees, getting it to the drying house, making it into a commercial product, and preparing it for shipment.

Incidentally much information will be got on the quantity of latex found in young trees, and the age and size at which tapping should best be begun. Such data are all to the good, for the object of the experiment is not to get rubber, but to find out accurately what the cost of collecting it is to be. Even if no rubber at all were obtained the data as to the time needed for making the cuts, setting and gathering the cups, carrying the containers to the drying shed and the rest would be distinctly worth while, for at present there are no figures available on the cost of these operations.

It perhaps should be said here that along with the tapping tests on the small trees there will alsc be made continued tappings of some of the older trees to ascertain how much rubber can be produced, and for how long a time it is expedient to continue to tap a given tree.

In working out the details of the experiment the plan broadened somewhat in scope, so that as it now stands the work that it is proposed to do falls under four main heads, as follows :—

First.—Experimental tappings to determine the cost of collecting latex under conditions of commercial practice.

Second.—Comparative tests of different methods of tapping to ascertain which one is best adapted to the local conditions, in view of cost, time required, effect on the flow of latex, and general influence on the tree.

Third.—A study of the methods of handling latex after it has been collected, with special reference to control by chemicals or by other means, so that as large a percentage as possible may be sold as high grade rubber. The best way of handling the "scrapings" is an important phase of this problem.

Fourth.—A study of methods of cultivation and fertilization, to find out how through these means the rubber trees may be brought sooner to the point of tapping, or by increased vitality be made to yield larger quantities of latex at an earlier age or for a longer period of flow.

Along with the main points enumerated much information should also be got on such related matters as the best spacing of the trees, the appropriate season of the year for planting, intercultural crops, and the like.

The work under the third head—methods of chemical control—will be performed at the laboratory of the Hawaii Experiment Station in Honolulu, as it is of a character requiring special equipment and knowledge only possessed by a trained chemist. There are enough rubber trees on the station grounds and in the Tamtalus forest to provide the necessary latex. All the rest of the work will be done in the field on the several rubber plantations.

Of what has so far been accomplished in these experiments Dr. Wilcox is to speak this afternoon.

The terms of the co-operative agreement as it now stands are that the Hawaii Experiment Station shall furnish the agent in charge of the field work, and shall undertake the chemical and other studies requiring laboratory equipment; the Division of Forestry pays the salary of the agent and the other necessary expenses. For this purpose $1,200 has been set apart from the appropriation of the Division. Each of the four rubber plantations at Nahiku has agreed to furnish one labourer for each time as may be needed, to work under the direction of the agent in charge, but to be paid by the plantation.

Early in September Dr. Wilcox, Mr. F. T. P. Waterhouse and I visited Nahiku and worked out on the ground, in conference with the managers of the four rubber plantations, the program that has since been put in effect. The investigation will be continued during the remainder of the present fiscal period, that is to June 30th, 1909. At its conclusion the results will be published either by the Experiment Station or by the Board of Agriculture and Forestry.

THE RISE IN RUBBER.

(From the *Indian Trade Journal*, Vol. XIV., No. 174, July 29, 1909.)

In the *Times* Financial and Commercial Supplement of July 2nd, 1909, there appears an article dealing with the rubber market. The writer says :—In 1906 the price for plantation rubber rose to 6s. 3d. and that for fine Para to 5s. 5d.; in 1908 the price for plantation rubber dropped to as low a figure as 3s. 0½d. and that for fine Para to 2s. 9d. per lb. This year prices have risen to a record height, plantation reaching 7s. and fine Para 6s. 3½d.; and at about this level the market remains at present.

The advance in 1906 was primarily caused by the fact that the demand due to developments in the electrical and motor industries was increasing at a greater rate than the supplies of rubber,

and by the consequent contraction in stocks of the commodity, but as the subsequent course of the market showed it was carried too far. From March 1906, to February, 1908, the course of the market was downwards. There were fluctuations, but from August, 1907, the fall was almost unabated, until in February of last year the low level quoted above was recorded. From that point the recovery was continuous to October, when plantation rubber reached 5s. 9d.; there was then a fall of 6d. by the end of last year, and since then the market has practically never receded.

In the light of past experience it can be safely said that while prices may have been pushed too high in 1906, they would not have fallen as low as they did in 1908, had it not been for the financial crisis in America, and its effects on trade in general and upon such industries as require large quantities of rubber. The American demand last year was not so important a factor as it had been in the three preceding years, and enlarged supplies were left for absorption by other countries. This demand, however, has revived during the past nine months, being persistently pushed at a time when the season was drawing to a close and supplies falling away, has been a material factor in bringing about the present high prices.

Increased Production.

The production of rubber has increased even when prices were low, the world's output in 1908 having reached 70,000 tons which was an increase of 1,000 tons over the output of 1907, and with such high values as have now been reached and seem likely to prevail in view of the growing trade requirements, unusual efforts will probably be made to bring rubber to the market. Last year there was an increase of about 850 tons in the production of plantation rubber (from Ceylon, Malaya, etc,), bringing the total up to 2,100 tons from an area of about 500,000 acres. This year a larger increase is expected, but it is evident that any material addition in the near future to the world's supply of rubber must come from South America where the production is in a large degree regulated by the returns upon the cost of gathering. It is said that with fine Para marketing at 3s a. lb. the South American supply could be counted upon as steady; with fine Para at about 6s. it is certain that extraordinary efforts will be made to extend the limits from which supplies are drawn, and in this connexion it is noteworthy that there is now a proposition before the Brazilian Government to order the construction of a railway which would open up a vast extent of rubber country that, owing to the difficulties of navigation in the upper reaches of the Amazon river during part of the year, is now but partially utilized. It is difficult to say how far production may expand in Brazil under the stimulus of high prices, but an increase may safely be counted upon. The growth in the output of plantation rubber must necessarily be slow, as rubber-growing in Ceylon and the Malay Archipelago is a comparatively new industry; but the number of new rubber companies which are being floated would indicate that the industry will be worked for all it is worth.

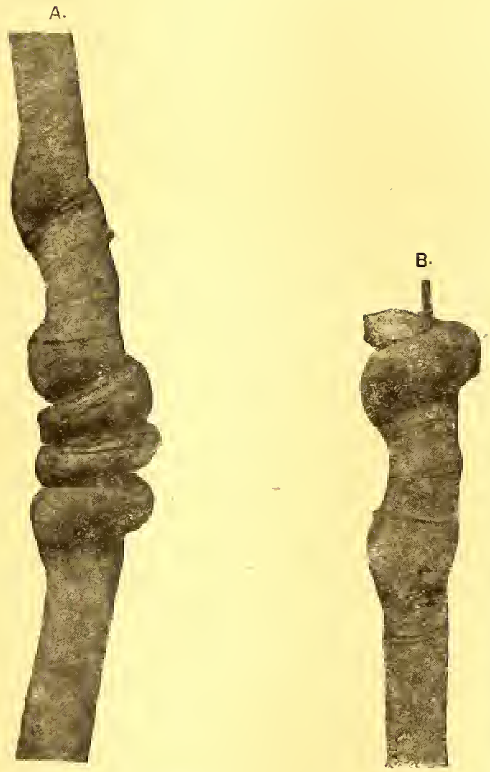
Meanwhile the comparative scarcity of rubber here and in America is undeniable. Reports from America say that stocks there are practically exhausted, while the stocks in London and Liverpool at the end of May were only 2,187 tons. as against 4,644 tons at the end of May, 1908. In May, 1908, the market was slow; at the present time it is strong with a keen demand.

A TWISTED HEVEA STEM.

By T. Petch.

The accompanying photographs show the stem of a two-year old Hevea, two inches in diameter. At a height of six inches from the ground, the stem makes three complete turns, and above these it is marked by a spiral groove for a length of nine inches. It will be seen from the photographs, that this spiral groove begins near the upper edge of the last coil. The specimen had been broken before it came into my possession, and the fracture is shown by the line across the middle coil, where some of the bark has been broken off in the attempt to fit the two pieces together. The coils are quite free from one another, that is, they are in contact but not fused together. The stem has undoubtedly been coiled completely round, three times; it is not merely grooved.

When the stem is broken across the middle turn it is seen to be coiled round a much thinner dead stem. This is evident in the second photograph, which shows the upper part of the stem inverted. From this, the explanation of the phenomenon is fairly simple. When the young tree was planted out in the field, it was, as usual, "stumped." The stem then died back to the next node, and the new leading shoot sprang from the bud at that node. But instead of growing straight up by the side of the dead stem, it coiled round it three times. The cause of this coiling is revealed in the



A TWISTED HEVEA STEM. × 1/6.

second photograph, where, still twined round the dead original stem, is seen part of some climbing weed. This climber grew up the stem of the young plant, and arrived at the bud just as the latter started into growth; and in twining further round the dead part of the stem it carried the young shoot round with it. When the two reached the top of the dead stem, the Hevea shoot grew straight upwards, and the climber then twisted itself round the green shoot; this is shown by the spiral groove on the upper part of the stem, which is caused by the pressure of the coils of the climber on the young stem as the latter expanded. It is most probable that the coils of the Hevea stem were at first wide apart, but that they have come into contact owing to its subsequent thickening. If the tree had been allowed to grow, the coils would no doubt have become fused into a solid mass.

OILS AND FATS.

SOY BEAN.

MEMORANDUM BY REPORTER ON ECONOMIC PRODUCTS.

(From the *Indian Trade Journal*, Vol. XIV., No. 174, July 29, 1909.)

The soy bean is called by botanists either *Glycine hispida* or *Glycine Soja*. Those who avoid the second name do so because Siebold and Zuccarini originally denoted the wild *Glycine* of Manchuria by it. But we may quite conveniently call this wild *Glycine* by another name which it possesses, viz., *G. ussuriensis*; and, as it has practically no literature, all that is written under the name of *G. Soja* belongs to the cultivated soy.

The origin of the cultivated plant is certainly the extreme east of Asia. It is far from being improbable that it was evolved from the wild *G. ussuriensis*; and, at any rate, when *G. Soja* degenerates, it may become very like that species (*vide* Prain in the *Journal* of the Asiatic Society of Bengal, LXVI, p. 403). If it was developed out of *G. ussuriensis*, then Northern China is its home. It has been long cultivated all over the east between Japan and Java. Its introduction into India is comparatively recent; and, except among those tribes or peoples who are mostly Mongolian, it has obtained little hold. I will state in what parts of India it may be found.

The Burmese grow it under the names of Pengapi and Pe-kyat-pyin, sowing it, never in great quantity, along with other beans on the mud banks as the falling rivers leave them bare in October, or more sparingly still away from the rivers. The Kachins and other hill-tribes grow a little of it on their hill-clearings, the Kachins calling it Lasi. The Khasis, the Nagas and other tribes between the Brahmaputra and Upper Assam cultivate it similarly. The Khasi name seems to be U-rymbaiktung and the Naga name An-ing-kiyo or Tzudza; but these three names should be subjected to scrutiny as they may be wrong. In the Brahmaputra valley it is grown, so far as is known, only towards Barpeta. Whether grown or not in the hills north of the Brahmaputra I cannot prove, but the probability is strong that it is. It is grown by the Lepchas in Sikkim, and is called by them Salyang or Selliangdun, or by the Bhutias Botumash Bhatwas or Bhatmars. It is apparently grown in the Kingdom of Nepal, for it is found just under the mountains in the north of Oudh and again in the valleys of the north-western Himalayas right to the extreme end, and sparingly up to an altitude of 6,000 feet. In western Bengal and through the submontane districts of the United Provinces it is rare, passing chiefly under the name of Ram Kurthi, or in Bengal also as Gari Kalai. Right upon the Nepal boundary it is known by the hill names, *e.g.*, Bhatnas or Bhatwas, as well as Kajuwa. The Santals grow it and call it Disom Horec. I saw it in 1902 sparingly grown towards Belgaum.

There are several races in India differing in small points; the seeds may be black or whitish, the leaves may be larger or smaller, etc. The black seeded races occur in the hills, the other colours of seed both in the hills and the plains. The Khasi hills contain both larger-leaved and smaller-leaved plants. Until comparative cultivation of these beans has been undertaken, no good classification of the races is possible. Harz has made a tentative one upon the shape and colour of the seed, but we may here pass it by.

In northern China, where great areas of soy bean are grown, there are known many races. Sir Alexander Hosie (*vide* his *Manchuria*, 1904, p. 181) grouped them thus:—

Yellow bean or Huang-ton,
white eyebrow (hilum) or—Pai-mei—
gives good bean curd,

golden yellow eyebrow or Chin-huang gives good bean curd,
black belly or Hei-chi.
Green bean or Ching-ton,
Black bean or Wu-ton,
large black or Ta-Wu-ton,
small black or Hsiao-wu-ton,
flat black or Pien-wu-ton,

We seem to have no green beans in India and nothing approaching the yellow Manchurian beans in shape nor the larger black.

Sir Alexander Hosie in another place (Report on the Province of Ssuch'uan, 1904, p. 4) states that the beans of this south-western province are white or red: their cultivation he adds (p. 43) is insignificant, rape supplying oil instead. I should imagine that they are in Ssuch'uan grown to a degree which corresponds closely with that of our Indian hills.

There have been made many analyses of soy beans—too numerous to be quoted here. Most of them may be found gathered together in König's *Chemie der menschlichen Nährungs und Genussmittel*, Vol. I, pages 595-600 and 1484. The seed contains about—

8	per cent	water.
35	,,	albuminoids.
18	,,	oil.
28	,,	non-nitrogenous extratives, starch, etc.
5	,,	fibre.
5	,,	ash.

Examining all the analyses I find that the percentage on dry weight of oils in beans from various countries is recorded to vary thus:—

Chinese beans	17·60	to	26·18
Japanese ,, ...	13·36	,,	25·55
Java ,, ...	18·37	,,	26·18
Grown in Europe	15·16	,,	21·89
Grown in North America ..	18·42	,,	19·52

I reserve the Indian figures. The average of eight analyses from China is 19·89. The average of six analyses from Japan is 20·01. The average of six analyses from Java is 21·62. The average of forty-two analyses from Europe is 18·98, being from Germany fourteen analyses with an average of 19·74, from Austria eleven, average 19·44, from Hungary six, average 19·16, from Russia nine, average 17·93, from France two, average 15·40.

Church (*Food Grains of India*, p. 141) gave the following analyses of Soja. I presume he had Indian seed, but it is not possible to say what race he examined:—

	Per cent.
Water	11
Albuminoids	35·3
Fat	18·9
Starch and sugar... ...	26·0
Fibre	4·2
Ash	4·6

Dr. Leather in 1903 analysed the seeds of seven samples of soy from Japanese seeds cultivated at Manjri, near Poona. The amount of oil in them varied from 14·92 to 23·05 per cent. being on the dry weight 15·97 to 24·41 per cent. with an average of 19·99.

My office is now studying the composition of the seeds of established races in order to see how they compare in oil content with such material as Manchuria exports, or such as Manchurian seed might give in India.

At the present time India has not the supply of these beans for an export trade; but possibilities of a certain extent are evident.

One of the first of considerations must be the yield that soy will give per acre in various parts of the country. Burma which, owing to its thorough Settlement operations, has for so many crops provided reliable ststistics, for this bean provides none—a consequence of the way in which it is seldom grown alone. When the bean in 1885 was grown experimentally at Nagpur from Japanese seed it yielded at the rate of 180 lbs. per acre (see Report Experimental Farms for that year, p. 5) but later (*vide* Nagpur Experimental Farm Report 1889-90, p. 5) it yielded but an average of 88 lbs. per acre over five years. In Lahore in 1894-95 (*vide* Report on the Government Agri-Horticultural Garden, p. 2.) it yielded at an estimated rate of 349 lbs. of seed per acre and 349 lbs. of fodder, but on a very small area. Its yield was very poor in the next year. The estimated yield in 1898 in an experiment done at Madras was 468 lbs. per acre. It has been grown sparingly at Nadiad in Gujarat, and elsewhere in the Bombay Presidency. In the Experimental Farm Report, Bombay, for 1901 a big yield was chronicled, but in the next year the crops at Poona and Surat failed. In 1903 the seeds analysed by Dr. Leather, as already reported, were grown near Poona: the yield is not recorded. In 1904 a yield of about 300 lbs. per acre was obtained (Experimental Farms Report, Bombay, p. 70) on light land. One year later nineteen plots were under trial, but with unpromising results, for only five yielded seed enough to repay for the cost of cultivation. The yield varied from 50 to 293 lbs. per acre, the five promising to be remunerative yielding over 200 lbs. per acre. The Manjri (Poona) Farm grew 19 plots in 1905-06 with better results, probably as a consequence of better land. Plot No. 3 yielded at the rate of 700 lbs. per acre, No. 13 at the rate of 690 lbs. per acre, No. 4 at the rate of 650 lbs. per acre and so on. Nearly all the plots gave

returns likely to be remunerative. One year later it was reported by Mr. Fletcher, Deputy Director of Agriculture, Bombay (Annual Report on the Agricultural and Botanic Stations for 1906-07, pages 15-16), that plot No. 5 had yielded on the edge of black soil at the rate of 1,166 lbs. per acre, while plots numbered 6, 7, 12 and 13 gave, respectively, 513, 650, 575 and 395 lbs. per acre.

Earlier than this in the United Provinces many experiments had been done at the Saharanpur Botanic Gardens (*vide* Gollan in Bulletin of the Department of Land Records and Agriculture, No. 21, 1906, pages 27-28). He obtained yields at the rate of 1,124 lbs. per acre and 561 lbs. per acre.

These experiments have not yet affected the ryots; the crop must be demonstrated very clearly as a paying one before it will do that. The one thing that we see from them is that the Agricultural Department has had the matter in hand. The crop as far as Manchurian seed is concerned is one for experiment only in those parts of India suitable for wheat, but what about the Javanese supply of seed? Van Gorkom in his Oost Indische Cultures, Supplement, 1890, in pages 283-287, gives a short account of the crop in Java where he says that it can be grown on a large scale. The Javan races should be tried in India along with those of more temperate climates.

We may add that other articles on soy beans, cake and oil appeared on pages 8 and 17 of the *Indian Trade Journal* of the 1st instant.

COCONUT CULTIVATION.

(From the *Queensland Agricultural Journal*, Vol. XXIII. I., Pt. 2, Aug. 1909.)

Dr. D. W. May, Director of the Experiment Station of Porto Rico, Leeward Islands, West Indies, in discussing the cultivation of the coconut in an article in the "Porto Rico Horticultural News," said:—

In planting coconuts it is important to select only fine, ripe seed nuts, the produce of healthy, well developed trees, of good bearing capacity. The ripe nuts are first set out at distances of 1 ft. from each other in holes 2 ft. deep, and with about 2 in. of the surface of the nut exposed. It is important that this seed bed should be kept moist but not wet. After a period of from four to six months, the young seedlings will have reached a size at which they can be transplanted to the ground in which the trees are to grow. The seedlings should be set out at distances of 30 ft. each way. It is a good plan to keep the soil around the young trees mulched with leaves and trash, as this has a helpful effect on the growth of the palms.

The coconut palm responds well to cultivation and applications of manure. The practice of green manuring is frequently recommended for coconut groves, and it is found that by growing crops of beans between the trees, and digging the vegetation into the ground, growth of the palms is considerably hastened.

Coconut palms bear transplanting well, and it is recommended that if the young trees do not appear to be flourishing, they may be taken up, some manure and trash worked into the hole, and the trees replanted.

The period at which the coconut palm begins to bear fruit varies from five to ten years, depending largely upon the location and the care given to it.

The fact that coconut palms are so commonly seen growing along coast lines and sea beaches indicates that the trees will do well in sandy soils. Probably, however, they flourish best of all on deep alluvial lands, such as those found near the mouths of rivers. A clay soil is very unsuitable for this crop. Since the saline surroundings of the sea coast is so congenial to the palms, it is customary in many countries, when the trees are planted inland, to place several pounds of salt in the holes in which the seedlings are set, with the object of making up for the want of saline constituents.

A good coconut tree should yield an average of 100 nuts per year, and under favourable conditions 200 have been obtained. Taking the whole island of Port Rico, however, a return of 65 nuts per tree is probably about the average figure obtained, and no doubt conditions are very similar in the British West Indian Islands. This low return indicates the general want of care and attention from which the industry is suffering.

The coconut palm will continue in bearing for so long as seventy or eighty years. During the early years of its growth, catch crops of various kinds, as provision crops, &c., may be planted between the trees, or, better still, leguminous plants, as cowpeas or velvet beans.

FIBRES

RECENT RESULTS IN THE CULTIVATION OF COTTON AT BARBADOS.

BY J. R. BOVELL, I.S.O., F.L.S., F.C.S.,
Superintendent of Agriculture, Barbados.

(From the *West Indian Bulletin*, Vol. IX., No. 3, 1908.)

In the paper on the cotton industry in Barbados which I prepared for the last Conference, I stated that, judging from the results so far obtained, the best time to plant cotton in Barbados in the black-soil districts, that is on the lower levels of the island, was from the middle of June to the beginning of August, and in the red-soil districts, on the higher levels, from about the beginning of August to the middle of September. Another year's experience with this crop confirms this statement. When cotton is planted late in the rainy season, the rainfall ceases before the plants are sufficiently matured to bear an abundant crop. On the other hand, speaking generally, when the seed is sown sufficiently early in the rainy season for the plants to be benefited by the rainfall and they are protected from the attacks of the cotton worm, they are vigorous and healthy when bolling time arrives, and good crops are obtained. Occasionally, cotton crops planted out of season have given good results, but these are exceptional.

The manurial experiments, which were instituted in 1902, a full description of which was given in the above mentioned paper (*West Indian Bulletin*, Vol. VIII., pp. 173-8), were carried out on two estates during the season 1906-7. Unfortunately, on one estate, owing to the fact that the division stakes were stolen, the overseer in charge of the gang picking the cotton allowed them to cross the boundary line between certain of the plots. The results, therefore, cannot be taken into consideration. On the other estate, owing to the unfavourable weather conditions which prevailed during the time the crop was grown, and which caused a number of bolls to drop, the results are inconclusive. I may, however, state that the best results were obtained on the plots which received 30 lbs. of nitrogen (N) as sulphate of ammonia, 60 lbs. of phosphoric acid (P_2O_5) as superphosphate, and 20 lbs. of potash (K_2O) as sulphate. The value of the increase over the plot which received no manure was $7·77, and that which received only phosphoric acid and potash $13·32. It may here be stated that last year the plots which received the same quantities of manure gave the second best results.

In the paper prepared for the last Conference, I gave the monetary results obtained with cotton crops grown on four estates, three in the parish of St. Philip, in which the largest area is planted with this crop., and one in the parish of Christ Church. Through the courtesy of the gentlemen in charge of these estates I am again able to give this year the results obtained during 1907. As will be seen therefrom, the results, owing to the unfavourable weather conditions, have been barely satisfactory, and had it not been that the price of cotton was above the average, the cotton crop would probably in two instances have resulted in a loss. The following is a summary of the results on these estates for 1907, compared with the results obtained in previous years:—

Estate No. 1.

Three years' (1903-6) crop. Average area	... 53 acres.
Average profit per acre per annum ...	... £9 17s. 10d.
Crop of 1907. Area	... 110 acres.
Average profit per acre	... £2 0s. 3d.

Estate No. 2.

Crop of 1906. Area	... 17 acres.
Average profit per acre	... £14 3s. 6d.
Crop of 1907. Area	... 46 acres.
Average profit per acre	... £2 19s. 7d.

Estate No. 3.

Crop of 1906. Area	... 16 acres.
Average profit per acre	... £9 8s. 11d.
Crop of 1907. Area	... 30 acres.
Average profit per acre	... £2 7s. 1d.

Estate No. 4.

Crop of 1906. Area	... 34 acres.
Average profit per acre	... £11 3s. 8d.
Crop of 1907. Area	... 100 acres.
Average profit per acre	... £7 9s. 4d.

In spite, however, of the diminution in the yields of cotton for the season 1906-7, the area planted in cotton in Barbados has been increased from 5,000 to 6,935 acres.

The following is a table showing the area of cotton planted and the quantity

and value of the lint exported from Barbados from 1902-8 :—

Year.	Average.	Quantity of lint in pounds.	Quantity of seed in pounds.	Value of lint.	Value of seed at £5 per ton.	Total Value.
1902-3	16	5,550	13,450	—	—	£318
1903-4	800	192,061	472,510	£12,388	£1,055	13,443
1904-5	1,647	344,232	846,882	20,869	1,890	22,759
1905-6	2,000	479,418	1,179,468	30,363	2,633	32,996
1906-7	5,000	852,408	2,042,840	72,326	4,560	76,876
1907-8	6,935	1,387,000*	3,317,121*	104,025*	7,404*	111,429*

*Estimated.

There is one matter in connection with the cotton industry in Barbados, which although receiving some attention at the hands of a few of the growers, has yet to be taken up by the majority of them, and that is the question of seed selection. This question is, as I said last year, of vital importance to the cotton growers in the West Indies, and unless growers regularly and systematically select seed for planting from the healthiest and best plants, the quality and yield will rapidly deteriorate. In 1906, the Imperial Department of Agriculture, through Mr. Thomas Thornton, Travelling Inspector in connection with Cotton Investigations, carried out seed selection on seven estates. On the seven estates, 264 plants were selected, and of these, only 14 were finally judged to be entirely satisfactory. For the season 1906-7, seed selection has been carried out on ten estates, and 224 plants were selected in the field. Of these 26 were ultimately selected. It is with pleasure that I now report that cotton picked from plants grown from the seed selected in 1905-6 is excellent in every respect.*

Until the planters in the West Indies recognize the great importance to the industry of careful seed selection, it will be impossible for the industry to make the advance it otherwise would.

Before closing my paper I should like to say a few words touching the loss the cotton industry in Barbados is sustaining through the departure from the island of Mr. Thornton. This gentleman, who has decided to withdraw from the Imperial Department to grow cotton for himself in the island of Tobago, has for the last three years been assisting the planters in Barbados and in the other colonies with the cotton industry and it is with much pleasure that I can bear testimony to the high appreciation in which his sercives are held by the planters in this island. From the beginning, he has endeavoured in every way possible to assist them and to advance their interests, and I am sure that I am only voicing their feeling when I say it is with much regret that they have learnt of his intended departure from the island.

* Seven bales of cotton from No. 303 (*West Indian Bulletin*, Vol. VII., p. 159) have been reported upon by Messrs. Wolstenholme and Holland as follows:—"It is the most serviceable class of cotton in the West Indies, and if it gives a better yield per acre than the finer descriptions—as it probably will—we think it is more suitable for extensive cultivation." —ED. *W. I. B.*

INDIAN COTTON SPINNING AND WEAVING.

(From the *Indian Trade Journal*, Vol. XIII., No. 158, April 8, 1909.)

In the *Indian Trade Journal* of April 12th, 1906 (page 55), we made an analytic study of the cotton spinning industry from data which had for the first time in history become available for statistical purposes, the main object being to show which have been the periods of great success and depression in the cotton spinning trade. In the year 1905-1906, the cotton spinning industry did fairly well; the period of greatest activity beginning in the month of April, 1905. Since then things have not gone so well with the industry. It has been estimated, for instance, that the profits for 1905, including commission, amounted to 3·47 crores; in 1906 there was a drop to 3·14 crores; in 1907 profits had further receded to 1·85 crores, while the estimate for last year was only 1·25 crores, and in some quarters this low figure is now regarded as much too high. Last year, of course, this industry shared in the wave of trade depression that passed over the world's markets, and at the present moment it is believed that the stocks of yarn held up in various parts of India is very considerable. On the other hand, the Indian harvest promises to be a good one, and, as the purchasing power of the people increases, the accumulation of stocks should vanish.

Following on the lines of the article published in 1906, we find that the number of spindles in position in Indian mills on the 31st March, 1908, which is the date of the latest returns available, was as follows :—

British India	...	...	5,437,798
Native States	...	...	257,532
All India	...	...	5,695,330

These and other figures which follow are contrasted with those of other years in a statement published below. The production of yarn in lbs. during the ten

months from April, 1908, to January, 1909, was :—

British India 523,423,304
All India 546,510,101

British India, therefore, produced in the ten months 96·26 lbs. per spindle, equal to 115·51 lbs. per annum, or a monthly average of 9·63 lbs. The production of yarn in British India in the five months from May to September, 1908, which was the busiest period in 1905, was 47·64 lbs. per spindle, which is equal to an annual production of 114·34 lbs. per spindle, against 138·25 lbs. in 1905, or a monthly average of 9·53 lbs. against 11·6 lbs. in 1905, which was regarded in the latter year as probably the normal maximum output. The output in British India in the months of July and August, 1908, was 8·89 lbs. and 9·47 lbs. per spindle, respectively. The average production of yarn per spindle in all India in the five months from May to September, 1908, was 9·51 lbs., or equal to a yearly total of 114·12 lbs. per spindle. The statement below shows at a glance the average production per spindle in British India from the date of our last article on this subject :—

Average production per spindle in British India.

Years.	Total production in British India.	Total number of spindles in British India	Average production per spindle.	Ratio of actual production to capacity.	Market value of shares, Percentage of face value	Dividend paid on ordinary share.	Percentage value of total seaborne trade.
1905-06	655,618,831	5,006,916	130·94	94·71	100	6·7	161·34
1906-07	630,553,315	5,230,020	120·56	87·2	138·85	6·7	172·96
1907-08	613,772,076	5,437,198	112·88	81·65	126·45	6·1	181·7
1908-09 (10 mhs)	523,423,304	5,437,198	(a) 115·52	(a) 83·56	121·8	6·7	—

(*a*) Equated to twelve months.

It will be observed that this statement illustrates not only the total production in British India, but the total number of spindles, average production per spindle, ratio of actual production to capacity, the market value of mill shares, the dividend paid on the ordinary shares, and the percentage of value of the total sea-borne trade in each year, the average of the five years ending 1894-95 being taken as 100.

By way of contrast we may now add that the number of looms on June 30th, 1908, the latest date up to which information is available, was as under :—

British India 63,955
Native States 2,549
All India 66,504

The production of woven goods in lbs. during the ten months from April, 1908, to January, 1909, was :—

British India 155,247,802
All India 162,100,522

British India therefore produced in the ten months 2,427 lbs. per loom, equal to 2,913 lbs. per annum or 243 lbs. per mensem. The production of woven goods in British India in the five months from May to September, 1908, was 1,162 lbs. per loom, which is equal to an annual production of 2,789 lbs. per loom, or a monthly average of 232 lbs. In July and August, 1908, the output of woven goods in British India was 178 lbs. and 238 lbs. per loom, respectively. The average monthly production of woven goods per loom in all India in the five months from May to September, 1908, was 233 lbs. or equal to a yearly total of 2,796 lbs. per loom.

The statement below illustrates more clearly the average production per loom in British India :—

Average Production per Loom in British India.

Years.	Total production in British India.	Total number of looms in British India.	Average production per loom.	Ratio of actual production to capacity.
1895-96 ..	Figures in	complete.		
1896-97 ..	81,415,058	34,277	2,375	79·69
1897-98 ..	88,026,427	34,047	2,585	86·74
1898-99 ..	98,658,289	34,761	2,838	95·23
1899-1900 ..	95,320,358	35,820	2,661	89·29
1900-01 ...	96,844,590	36,962	2,593	87·00
1901-02 ..	115,966,159	38,643	3,001	100·7
1902-03 ..	117,284,632	40,149	2,921	98·01
1903-04 ..	131,876,227	41,729	3,160	106·03
1904-05 .	152,741,830	43,740	3,492	117·17
1905-06 ..	156,600,276	48,550	3,226	108·25
1906-07 ..	159,001,465	54,291	2,929	98·28
1907-08 ...	181,269,219	62,251	2,912	95·71
1908-09 (ten months)	155,247,802	63,955	2,913(*a*)	97·75

(*a*) Equated to twelve months.

It may be explained that in column 5 the standard maximum capacity of a loom has been arrived at from the monthly average production of the ten months ending January last, which is 2,980·2 per loom annually ; but columns 6 and 7, as in the spindle statement previously given above, have not been worked out, as both spinning and weaving mills are included in the corresponding columns of that statement.

CULTIVATION OF EGYPTIAN COTTON IN SIND.

(From the *Bulletin of the Imperial Institute*, Vol. VI., No. 4, 1908.)

During recent years an attempt has been made by the Bombay Government to establish the cultivation of Egyptain cotton in the province of Sind and the valley of the Indus. The climatic condi-

tions in this region are said to resemble those of Egypt. The soil is a sandy loam, the atmosphere is clear and dry, and the rainfall is sufficiently limited for the crop. The most important point, however, is the existence of canals which enables a system of irrigation to be carried out, similar to that practised in Egypt.

The experiments were commenced in 1904, on a plot of land on the Hiral Wah canal, in the Thar and Parkar district. Four varieties, Abassi, Mitafifi, Yannovitch and Ashmouni, were planted. The experiments were very successful, and the yields compared favourably with those usually obtained in Egypt. The staple showed some deterioration, which was greatest in the Mitafifi and least in the Yannovitch.

In 1905 an experimental farm was started at Mirpurkhas, and seed was distributed to certain cultivators for trial under the supervision of the Department of Agriculture. The total area planted amounted to 1,000 acres, the whole of which was situated on the Jamrao Canal, in a district measuring 2,000 square miles. The season was somewhat unfavourable, but a yield of approximately 450 bales was obtained. The cotton realised very encouraging prices, eleven bales being sold in Liverpool at 9*d.* per lb., when "good fair" Egyptian was quoted at 10*d.* per lb. The greater part of the crop was purchased by a firm of exporters, the price obtained by the cultivators being 5½*d.* per lb. for Mitafifi, and 7½*d.* per lb. for Abassi.

The area planted with Egyptian cotton in 1906 amounted to 5,098 acres, and consisted, as in former years, of small plots scatted over a very large area. The cotton was received at Mipurkhas and sold by auction. This system of collection and sale by the Government will be continued until the industry is firmly established. The average yield was probably less than 160 lb. of seed-cotton per acre. This low yield is accounted for by lack of care on the part of some cultivators, and the ravages of the boll-worm. The cotton, when not stained by the boll-worm, was equal to the average quality of Egyptian Abassi; it was of good length, but was said to have deteriorated in strength.

During 1907 about 2,000 acres were planted with Abassi seed obtained from the 1906 crop ginned in Sind, and 4,335 acres with Mitafifi seed imported from Egypt. The plants were not attacked to any extent by the boll-worm, but in most cases sufficient care was not exercised in the cultivation, and excessive irrigation was practised. The total crop was probably about 1,800 bales of seed-cotton, each of 400 lb. About fifty-five bales of Abassi and three hundred bales of Mitafifi were sold by auction at Mirpurkhas, and realised satisfactory prices. The chief buyers were the Ahmedabad and Bombay mills, and one or two exporting firms. It was reported that samples were being purchased for export to Japan.

The area planted during the present year is of approximately the same extent as that cultivated in 1907. Fifty-six tons of Abassi and eleven tons of Mitafifi seed have been distributed.

COTTON CULTIVATION IN THE SEA ISLANDS.

(From the *Agricultural News*, Vol. VIII., No. 187, June 26, 1909.)

The Director of Agriculture of the Nyasaland Protectorate (Mr. J. Stewart McCall) some time ago paid a visit to the United States, in order to study the methods of cotton cultivation practised in that country, and the information gathered as the result of his visit is published in a small bulletin (No. 1 of 1909) recently issued by the Nyasaland Agricultural Department. The following notes are an abstract of the section of the pamphlet which deals with the cultivation of fine staple cotton in the Sea Islands:—

The amount of Sea Island cotton grown in the United States forms less than 1 per cent. of the whole American cotton crop, but it is of great importance owing to its high quality. It is grown to the highest perfection on James and Edistow Islands, which lie to the west and south-west of Charleston, in the State of South Carolina.

Sea Island cotton is most sensitive in regard to changes of soil and climate. It does best on light sand and gravel alluvia, not too rich in humus, with free drainage, and a fairly humid atmosphere.

On the best plantations in the Sea Islands, about 75 per cent. of the whole area is known as 'cotton land,' and the other 25 per cent. is devoted to the growth of truck crops.

Cotton is not grown continuously on the same land, however, but only in alternate years. Land which has borne cotton in one year is either planted with some leguminous crop, such as cowpeas or velvet beans, in the following season, or simply left unploughed. When green crops are grown they are fed to animals on the land.

The cotton is planted in March and April, at distances of 22 inches from plant to plant, and 5 feet from row to row. About the end of August the first pickings begin, and the harvest continues until December.

Much of the finest cotton grown in the Sea Islands never enters the open market at all, being sold privately to French lace manufacturers at a high price.

The cotton grown on the Islands is much superior to the Sea Island cotton produced on the mainland. The inferiority of the latter, which consists in shorter staple and lack of lustre, is partly due to the large amount of hybridization which takes place with the Upland cotton grown in the neighbourhood, and partly to the lack of humidity in the atmosphere. On the mainland the best cotton is said to be produced by a crop raised from island-grown seed.

Cotton growers in the Sea Islands are firm believers in seed selection, which they practise regularly. Mr. McCall reports that each of the island plantations visited by him had its own breeding and selection plot, and there can be little doubt that the high quality of the cotton produced is to a large extent the result of prolonged selection. Great intelligence is exercised by the island planters in growing and harvesting their cotton. Manuring of the land is frequently commenced as early as November, when if pen manure is available, it is applied at the rate of 20 tons per acre on the surface between the old ridges. Otherwise, a dressing of cotton seed, at the rate of about ½-ton per acre is given early in Feburary, when the first ploughings are made. This seed is covered by splitting the old ridges with the plough, and the great bulk of it undergoes decay. Any seeds which germinate are destroyed by subsequent ploughings. It is found that late applications, on a large scale, of slow-acting organic manures interfere with germination of the cotton seed, and retard the ripening of the crop.

The tillage operations practised frequently include two or three ploughings, of which the first is deep (12 inches when possible). Subsequent ploughings are more shallow. The first ploughing provides conditions suitable for deep rooting, and enables the plants to be drought resistant. The shallow cultivations, which follow, result in the production of a fine surface tilth, which is so necessary for germination and rapid early growth during the weak stages before the plant puts on the rough leaf.

When the land is ready to be ridged up for planting, a manure such as 600 lb. of Peruvian guano, and 50 lb. of potassium sulphate is applied per acre, and after germination 50 lb. of nitrate of soda is added.

Cotton grown in the Sea Islands is marketed in bags, 7½ feet long by 2½ feet in diameter, containing approximately 350 lb. of lint. This cotton is not compressed in bales, since many of the planters consider the practice detrimental to the fibre. Practically all the Islands' crop is sold at Charleston, and forms 35 per cent. of the cotton marketed at that port. Sea Island cotton from the mainland is principally marketed and shipped from Savannah.

PAPER AND PAPIER MACHE IN BENGAL.

(From the *Indian Agriculturist*, Vol. XXXIV., No. 4, April, 1909.)

The following is a summary of the admirable monograph on the subject by Mr. D. N. Mookerjee, M.A., who was put on special duty by the Bengal Government for the work :—

Paper consists of a compacted web or felting of vegetable fibres usually, as we know so well, in the form of a thin flexible sheet. The fibres are reduced to a pulp by grinding, beating, etc., and are diluted with water in a vat. Pulp from the vat is then dipped up in a mould from which the water drains away leaving a felted sheet which is then pressed and dried.

Papier Mache is made of paper-pulp reduced to a paste and then boiled with a solution of gum arabic or size to give tenacity to the paste. Articles such as trays, picture-frames, jars, boxes, etc., are shaped by moulding, and then ornamented and varnished. Sometimes instead of paste several sheets of paper are glued together and given the required shape.

There is no papier mache industry in Bengal.

The chief difference between hand-made and machine-made paper is that while the former is made in separate sheets of limited sizes, machine-made paper, though limited in width, runs off from the machine in long rolls frequently more than a mile in length without a break. Although the use of machines is all but universal now in Europe and America for ordinary papers, some of the more costly description—drawing paper, for instance—are still hand-made.

Esparto grass, straw, and wood are now largely used in the fabrication of pulp suitable for printing paper; bagging, canvas and old rope are used for brown, and other coarse papers; but hitherto no substance has been found to supersede or even to satisfctorily supplant rags for the finer kinds of paper (writing and drawin g).

In China and Japan even to the present day paper is made by hand. The Japanese paper is chiefly made from material derived from a kind of mulberry (Toont) (*Morus payrifera sativa*) and is known as kadji. In China almost every province, if not every district, is said to have its own peculiar paper material.

In ancient times various materials were employed in India for writing. Stones, bricks, wooden boards, chips of bamboo, metal plates (especially those of copper), and above all palm-leaves and birch-bark, bhurja (*Baetula bhojpattr*) were all in use. The last is even called lekhana or "The writing material," and written documents go by the name of bhurja. The art of preparing the bark for use has now been lost; but birch-bark manuscripts are said to be still common in the libraries of the Kashmir pundits. They are, however, very rare in the Khatmundu Library in Nepal, where most of the ancient manuscripts are found written on palm-leaves.

Skins of animals so common in other countries were not much in vogue in India, probably on account of their being ritually impure. Alburini, who visited India with Mahmud of Ghazni and gave a detailed account of the manners and customs, science and literature, arts and industries of the people of this country, expressly says, "The Hindus are not in the habit of writing on hides like the Greeks in ancient times." A reference to this practice is implied in the reply given by Socrates when he was questioned as to why he did not compose books: "I don't transfer knowledge," said he, "from the living hearts of men to the dead hides of sheep."

The use of well-beaten cotton cloth as a writing material by the Hindus is mentioned by Nearchus who was one of the generals of Alexander the Great. The Kanarsese traders still use for their books of business a kind of cloth called kadatam, which is covered with a paste of tamarind seed, afterwards blackened with charcoal. The letters are written with chalk or steatite pencils, and the writing is white on black (Mysore Coorg Gazetteer, 1877, 1, 408).

The manufacture of paper in Europe was first established by the Moors in Spain. In Italy also the art of paper-making was no doubt in the first place established through the Arab occupation of Sicily. Paper, however, continued to be made by hand till at the close of the 18th century Louis Robert, a clerk in the employment of Messrs. Didst, of the celebrated Essonnes paper mills near Paris, invented machinery for making the process continuous. This was the greatest advance in the history of the industry, and modern paper-making may be said to date from that time.

The first authentic account of paper-making in India dates from the time of the Emperor Akbar, when the art is said to have been introduced into Kashmir. It spread rapidly all over India and displaced the birch-bark and palm-leaves that were previously used for writing. The Persian word for paper, 'kagaj,' has been adopted in most Indian languages. This also points to the Mahomedan introduction of the industry. The Sanskrit word for that which is used for writing upon is *patra*, the same as *pata* in Bengali.

It is probable, however, that the art of paper-making came from China to the inhabitants of Eastern Himalaya long anterior to the introduction of the paper industry into Kashmir by Akbar. Rajendra Lala Mitra asserts that a "letter-writer" by King Bhoja of Dhara proves its use in Malwa during the 11th century A. D. (Gough's papers, 16). This King, it may be mentioned, reigned from 1106 to 1142 (?) and was one of the Hindu Chiefs who fought Mahmud of Ghazni. At any rate paper had not yet become common in India, unlike in Mahomedan countries, at this time.

Paper manuscripts, dated Vikrama-Samvat 1384 and (A. D. 1394, 1327-28 and 1337-38), the leaves of which are cut according to the size of palm-leaves, have been discovered by Peterson at Anhilvad Patan. It is very doubtful if any of the ancient manuscripts from Kashgar which are written on a peculiar paper, covered with a layer of gypsum, are of Indian origin; Dr. Hoenle believes that all of them were written in Central Asia.

During his recent visit to Khatmundu Pandit Haraprasad Shastri acquired a Sanskrit manuscript belonging to the 11th century A. D., written on Nepal paper.

It may be interesting to mention that paper is made in Nepal partly from bamboo and partly from the bark of a small thorny shrub known as Mahadeva's flower (*Daphne cannabina*). The surface is made glossy by rubbing with a smooth piece of stone. The Daphne paper is generally very thick and is made thicker

and stiffer by being coated over with a paste made from the boiled kernel of tamarind seed. It is coloured yellow on one side, probably with turmeric. Thus prepared the paper becomes very hard and looks almost like a piece of hide. But the use of the paste from tamarind seed makes the paper unfit for the transcription of sacred texts. As we shall see later on, in Bengal, and perhaps, elsewhere in India, a solution of starch made by boiling sunned rice is used for sizing paper. This operation is called 'tulat.' Paper which was subjected to this process was avoided by the old pundits for writing their 'pothis.'

Excepting in the case of correspondence with the outside world the Nepal Government never uses any machine-made foreign paper.

The Daphne paper, though commonly known as Nepal paper, is really mostly made in Bhutan. But the Bhutias also use the bark of another plant locally known as 'Diah' for paper making. The process followed is just the same as in China and Japan.

Paper-making is a dying industry in the province. Only a generation ago it was still in a flourishing condition. Within this short period it has completely disappeared from many districts. At present the industry, such as it is, exists only in three districts in Bengal: in Hooghly, Howrah and Murshidabad. In in Howrah the industry is confined to a single village named Mainah three miles from Amta Railway Station in the Uluberia subdivision. In Murshidabad it is confined to two villages named Kristopur and Srirampur, in thana Samserganj in the Jangipur Subdivision. In the Hooghly district it is made at Manad and Gossainmalpara in the Polba police-station, at Neala in the Pandua police-station, at Shahbazar and other villages in the Dhaniakhali police-station and at Bali Dewanganj in the Arambagh Subdivision.

It is in the hands of a class of Mahomedans known as Kagjis or paper-makers. The sight of a kagji village is most melancholy. So far as the paper industry goes the crude hand tools in use in this country have apparently no chance whatever against machinery. At Mainah near Amta in the Uluberia Subdivision, Howrah district, out of 100 families that carried on the industry 30 or 35 years ago, only half-a-dozen families still desperately stick to their old profession, the rest having either turned cultivators or labourers or having left the village. The Kagji villages in the Hooghly district are, if possible, only in a worse plight, having been devastated by malaria in addition to the havoc caused by the competition of machine-made paper. Paper-making used to be carried on at Nasriganj in the Shahabad district, but the industry ceased to exist some years ago. The Collector of Cuttack reports that about 30 years ago a small paper-making industry was carried on by some Mahomedans of Hariharpur. There are still seven men who can make paper, but the industry is dead. The paper was made from straw, and though rough and coarse was formerly used in the Collectorate Record-room for fly-leaves, but its use has been discontinued for some years.

At Shahbazar near Tarkeswar (district Hooghly) in place of 70 'dhenkis' (as the mortar-and-pestle arrangement for producing the pulp is called) only two are still in use. The large pieces of stone that once served as mortars for the 'dhenkis' lie scattered about, sometimes serving only as steps for their houses. The people sorrowfully point to the large tanks their forefathers had excavated from the profits of paper, and which have now become silted up containing only a little dirty water.

The only material now used by the Kagjis of Hooghly and Howrah for making paper is waste or refuse paper. Book-binder's shavings are a particularly valued material. Formerly old sacking and fishing nets were also used for the manufacture of brown paper, but it has ceased to pay and is no longer used. In the Jangipur subdivision, Murshidabad district, however, jute cuttings are still used for making a kind of brown paper.

But if the essence of the art of paper-making be, as already mentioned, the minute subdivision of the raw fibrous material with a view to obtaining the pulp the small industry as still carried on in the province hardly deserves to be called paper-making at all. It is a mere recasting of the old material like the producion of glassware from broken glass.

The paper produced is a kind of coarse stuff used by Indian merchants and zamindars for keeping their business accounts. The paper is almost exclusively used, for instance, in the office of the Maharajadhiraj of Burdwan. It is also used by astrologers for writing people's horoscopes, for though coarse, it is believed to resist the ravages of insects and climate better than machine-made paper. Towards the close of the Bengali year, when new account books are prepared for the coming year, this paper is a good deal in request. After this during the rest of the year the demand is small.

It appears that the new 'swadeshi' movement has done very little to stimulate interest in this industry. The Kagjis think that while people are to a large extent patronising handloom products in the matter of clothing, so far as paper goes, they content themselves with the products of the European factories in the country.

An explanation may lie in the fact that, unlike clothes, a good deal of the paper in ordinary use is devoted only to a very ephemeral purpose where the quality of long endurance has no place to warrant the payment of the much higher price demanded for hand-made paper. Besides, the supply of hand-made paper is too small at present to meet the demand.

But soon the present race of workmen who still know the art will be gone, making a revival of the industry or its improvement impossible.

The Kagjis declare it would be very easy for them to produce thicker or thinner paper than they now make if there was a demand. Paper, a little thicker than what is now known as Baleswar, would be very suitable for being made into post-cards and tramway or even railway tickets. Again, if the paper is left unsized, it would make good enough blotting paper. The mats upon which the wet sheets are put out to dry, being of very uneven surface, produce a corresponding unevenness in the sheets, but, with a slight improvement in the arrangement for drying, this could surely be most easily remedied.

The process of manufacture is as follows :—

Waste paper is mixed with lime and steeped for a week or ten days in a large earthen vat. The lime used is at the rate of three or four seers per maund of waste paper. When sufficiently softened, the mass is pounded under a 'dhenki' over a stone mortar. The 'dhenki' used for this purpose is very much like that used for husking paddy, only somewhat larger and heavier and the head of the pestle is more strongly bound with iron. The stone mortar is only slightly grooved and consists of a large piece of basaltic stone, some three feet long, one and-a-half feet broad and a foot high.

The paste produced after pounding with the 'dhenki' is next kneaded thoroughly in another vat by trampling under feet like potter's clay.

The paste is now washed thoroughly in water over a piece of cotton cloth till all impurities are got rid of and a soft pulp obtained. This is now diluted with water in a large vat. The contents of the vat are constantly stirred with a rod to prevent the pulp settling down, and a little is dipped up at a time in a rectangular skeleton mould, called a decle, resting on a fine sieve. This sieve is made of very thin bamboo slips strung together with horse-hair. The sieve is known as 'chhapri,' measures 23 in. by 18 in., and looks something like a piece of ordinary verandah 'chik,' only very much smaller and finer. The chhapri or sieve is stretched over a wooden frame and is held firmly in position by the decle or rectangular mould pressing on its four edges. On withdrawing the mould from the vat in a horizontal position the water within the decle drains off, leaving the chhapri covered with a thin film of fibres, the operator meanwhile shaking the mould so as to evenly distribute the film.

The chhapri covered with the thin film of paper is now taken off from the frame and inverted over a slanting piece of stone covered with a piece of gunny cloth. The chhapri is now rolled away, leaving the film of paper on the stone. The process is repeated and film after film laid down one above another forming a pile. This work is generally done in the morning and the pile is left untouched for the water to drain away till the following day when the sheets still wet are taken up one by one and laid separately on mats to dry in the sun.

After their edges have been trimmed the sheets are next sized or starched one side at a time and again dried. The starch is obtained by boiling sunned rice in water and is applied with the spongy fibrous shell of a "dhundul, nenual" or "vurul" (*Luffa ægyptiaca*) with the outer skin removed. Some blue stone or copper sulphate is dissolved in the starch to improve the lasting quality of the paper. The starching being light, work is generally done by women.

After the sheets have been dried, they are exposed to the night dew to soften them slightly, and next morning they are pressed over a plank with the help of a piece of smooth stone or a conch shell. This, too, is generally done by women. The paper is now ready.

The paper produced is generally white, but is sometimes coloured blue or yellow. The blue colour is imparted with indigo dissolved in the pulp vat from which the films are dipped up with the chhapri. The yellow colour is given by dissolving turmeric in the starch. Yellow paper is only produced in the Hooghly district.

The implements used, it will thus be seen, are of the crudest kind possible;

they consist of some earthen vats, dhenki for pounding the waste paper, a wooden mould, a bamboo sieve (chhapri), a wooden frame for supporting the chhapri, some mats for drying the sheets, some dhundul fruits for applying the starch, and a piece of plank and a smooth stone for pressing the paper. The chhapri alone is a rather delicate thing. It is procured from Serampore in the Hooghly district where it is made. It costs from Re. 1-4 to Rs. 2, and each piece lasts from 2½ to 3 months.

The dipping up of the pulp with the chhapri is an operation requiring some skill. One man can on an average produce 175 to 200 sheets per day (7 to 8 quires). One woman can size one side of 16 or 20 quires and polish about 12 quires of paper per day. The workmen receive from Rs. 6 to Rs. 10 or Rs. 12 per month according to their skill and outturn of work.

One maund of waste paper makes about 30 seers of country paper.

Paper is made in several sizes :—

Bara rukhi (the width of 12 fingers laid side by side) ...	12 quires.
Sola rukhi or jangri (the width of 16 fingers laid side by side)	4 or 5 ,,
Baira (generally used in zamindari sarishtas)	8 or 9 ,,
Baleswari white or blue (a thick paper only made at Amta, district of Howrah) ...	2 ,,

In this country hand-made paper has apparently no chance against paper made by machine. But in England the most expensive writing and drawing papers are still made by hand. Some 60 or 70 tons of it are said to be made in every works in Great Britain, and on account of its superior strength there is a steady demand for it. In America, however, papers of great strength are manufactured by machinery and not much hand-made paper is produced.

Even in the case of hand-made paper the pulp is always made with machine, only the finest qualities of rags being used for the purpose. The 'chhapri,' instead of being made of bamboo slips, consists of a fine wire cloth. The sheets of paper as they leave the mould, instead of being filed up in direct contact with each other, are separated from each other by felt placed between one sheet and the next. The sheets are dried with particular care and the sizing is done with gelatine. The glazing is done by machine as in the case of other paper. The greater strength of hand-made paper is supposed to be due partly to the time allowed to the fibres to knit together, and partly to the fibre expansion permitted them during drying.

But in China and Japan common paper is said to be still made by hand. It would be interesting to ascertain under what conditions this has so long been possible, and what the prospects of the industry may be. It is superfluous to say that there is a good deal in common between the industrial conditions of those countries and India, for instance, the low wages of labour, the simplicity of tools, the general absence of the factory system, etc. Some of the students lately sent to Japan by the Society for the Industrial and Technical Education of Indians might look into the problem. Government might also obtain a report from some authoritative agent on the subject. Poor, ignorant and broken-spirited, it is hopeless to expect the Kajis to make any improvements in their time-honoured ways without some help from outside. It is impossible to say without an inquiry abroad whether the industry has any chance of being saved at all. The few men who are still engaged in it will soon disappear, and their descendants will be forced to betake themselves to other lines of life as best as they can. And then it will be too late to make any effort to revive the industry.

DRUGS AND MEDICINAL PLANTS.

NOTE ON IPECACUANHA CULTIVATION.

BY E. M. HOLMES, F.L.S.,
Curator of the Pharmaceutical Society's Museums.

(From the *Agricultural Bulletin of the Straits and F. M. S.*, Vol. VIII., No. 8, August, 1909.)

About a year ago I pointed out, with respect to the Ipecacuanha cultivated near Klang, in the protectorate of Selangor, that it was found by Mr. Pfenningwerth, the manager of the estate where it is cultivated, that although the fresh crop from fresh soil was a fairly good one, on trying to raise a second it invariably turned out very poor, although all kinds of manure had been tried to enrich the land, without apparently restoring to the soil the necessary ingredients for luxuriant growth. Under these circumstances, it occurred to me that it would be interesting to determine the mineral constituents of the root itself, so that if these were known

See p. 307. *Photo by H. F. Macmillan.*

THE DURIAN FRUIT.
(Durio zibethinus).

they might indicate the mineral manure that should be added to the soil. Moreover, if these constituents were found to occur in similar proportion in the root collected in such widely distant localities as Matto Grosso, the United States of Colombia, and Selangor, it would still further emphasise the need of such ingredients being required by the plant. Fortunately, I found in Mr. G. S. Blake, B.SC., A.R.S.M., an analytical chemist willing to undertake the analysis of Brazilian, Carthagena, and Selangor Ipecacuanha roots as met with in commerce, and I have at length received his report. The details as given below seem to indicate that phosphate of lime and salts of magnesia and potash are the principal ingredients required by the plant. A certain amount of potash would probably be yielded by the leaf mould in which the plant grows, but lime and magnesia are not so equally distributed as a rule, and it is possible that on a siliceous soil these elements might be deficient. The quantity of calcium oxalate present in Ipecacuanha root in the form of raphides indicates that lime is used in building up the tissues of the plant. At all events, the use of these bases—the lime in the form of phosphate—is worthy of trial. Fortunately, Mr. Blake has now left for Matto Grosso in connection with a Baptist Missionary expedition to that province, to conduct scientific investigations, and has kindly promised to examine the soil in which the Ipecacuanha plant grows, and the other natural conditions under which the plant flourishes in the wild state.

Analysis of Ipecacuanha Root.

BY M. G. S. BLAKE, B.SC.

Composition of Ash.	——	Brazilian. %	Carthagena. %	Selangor. %
	Ash	2·04	2·72	1·80
Potash ...	K_2O	25·53	7·42	28·55
Soda ...	Na_2O	2·70	2·25	2·06
Lime ...	Ca O	15·50	17·00	16·87
Magnesia ...	Mg O	13·57	10·68	14·25
Manganous Oxide	Mn O	0·30	0·58	0·45
Phosphoric Oxide	P_2O_5	12·70	5·16	13·81
Sulphuric Oxide	SO_3	7·40	5·05	8·57
Silica ...	SiO_2	11·02	—	10·50
Chlorine ...	Cl	Trace.	Trace.	Trace

—*Pharmaceutical Journal and Pharmacist*, June 5th, 1909, p. 765.

EDIBLE PRODUCTS.

THE DURIAN FRUIT.

BY H. F. MACMILLAN.

(*Illustrated.*)

Durio zibethinus (N. O. Sterculiaceæ)—"Durian," sometimes called the "Civet-cat fruit."—A very large, handsome pyramidal tree, native of the Malayan Archipelago, and commonly cultivated in the Straits, Burma, Java, etc., for the sake of its celebrated fruit. The latter is produced on the older branches, varying somewhat from round to oval in shape, and weighing from 5 to 7 lb. or more. It is armed with thickly set formidable prickles about ½ inch long; when ripe it becomes slightly yellow, and possesses an odour which is intensively offensive to most people, especially on first acquaintance with it. The cream-coloured pulp surrounding the seed is the edible portion; this is most highly prized by Malay and other oriental people, and is also relished by Europeans who acquire a taste for it. Firminger described it as "resembling blanc-mange, delicious as the finest cream," whilst Mr. Russel Wallace considered that "eating Durians is a sensation worth a voyage to the East." The large seeds may be roasted and eaten like chestnuts. Pounded into flour, they are said to be sometimes made into a substance like "vegetable-ivory." The Durian thrives in the moist low-country of Ceylon up to 2,000 feet elevation, and luxuriates in deep alluvial soil. In Peradeniya Gardens there are magnificent trees well over 100 feet in height. They flower in March or April, and the fruit is usually ripe in July or August. Durian fruits are variable in size, shape, flavour and quantity of pulp, according to variety. The trees also vary in productiveness, some varieties being almost barren. Selection and high cultivation should, therefore, be practised in order to obtain the best fruits. The tree is readily propagated by seed if sown fresh; the seed is of short vitality, and germinates in 7 to 8 days.

PACKING DURIAN SEEDS FOR EXPORT.

BY T. W. MAIN.

(From the *Agricultural Bulletin of the Straits and F.M.S.*, Vol. VIII., No. 3, March, 1909.)

During the past year several experiments have been carried out at the Botanic Gardens, Singapore, in order to

determine the best method of packing Durian (*Durio zibethinus*) seeds for export to other tropical Colonies. Hitherto it had been thought that seeds of this much-sought-for fruit would not travel any distance successfully owing to it germinating so quickly after becoming ripe, and there would appear to be some grounds for this assumption; in fact several attempts were made in years past to send seeds from this Department to Ceylon with scanty success. These failures must, however, have been due to a want cf knowledge as to the proper method of packing and not so much to the inability of the seeds to retain their germinating powers for any lengthy period.

Seeds of the nature of those of the Durian having no outside hard protecting covering or testa are, as a rule, difficult to transport to any great distance partly owing to the fact that they germinate so quickly if not properly dried, and also to the fact that they rot very rapidly if there is the slightest suggestion of moisture in the packing material. As far as our knowledge goes, we have proved fairly conclusively that those seeds travel best which have *no packing material*, provided that they are thoroughly sun dried previous to being put in the tins. Care should also be taken to see that the edible pulpy matter which surrounds the seeds is carefully removed. Seeds prepared in this manner by us have travelled thousands of miles and arrived at their destination in excellent condition.

On the 27th of August, 1908, eight tins of Durian seeds were sent to the Superintendent, Agricultural Department, Onitsha, Southern Nigeria, packed as follows:—

Tin No.	1	packed in	Burnt padi husk
,,	2	,,	Wood-wool
,	3	,,	Tissue paper
,,	4	,,	Thoroughly dried soil
,	5	,,	Thoroughly dried Moss dust
,	6	,,	Slightly damp moss
,,	7	,,	Slightly damp moss
,,	8	,,	Had no packing whatever

Mr. Don, in his letter of acknowledgement, reported as follows on the condition of seeds on arrival at Onitsha (20-10-08):—

"The seeds, with the exception of those in tin No. 1, arrived in fair condition considering the long distance they had to travel.

"The seeds in tin No. 1 were completly spoilt.

The seeds in tin No.	2	five seeds out of 6 were good.
" ,,	3	six out of 12 good, 4 germinated in the tin.
" ,,	4	three out of 7 were good, 3 germinated in the tin.
" ,,	5	eight out of 10 were good.
" ,,	6	four out of 10 were good, 2 germinated in the tin.
" ,,	7	nine out of 11 were good, 6 germinated in the tin.
" ,,	8	thirteen out of 15 were good."

The seeds in tin No. 1 were packed in burnt padi husk, the material which we find most successful for packing Para rubber seeds, and it is interesting to note that in the case of the Durian seeds it totally failed to preserve them. The packing material employed for tins No. 2 and 5, namely, fine wood-wool and thoroughly dried moss dust gave the best result, whilst tin No. 8 in which no packing whatever was used was the most satisfactory of all.

A later consignment of several hundreds of seeds to the same Department in Southern Nigeria, packed in powdered charcoal, arrived in very bad condition.

Our observations lead us to believe that the most successful method to adopt is to first carefully clean all pulpy matter from the seeds, and after thoroughly drying them in the sun for two or three days, pack them in tins sufficiently large to hold fifty seeds. The lids of the tins should not be soldered down and stout canvas should be used as a covering.

The method applies to all seeds of a like nature, such as Mangosteen, etc., etc.; packing large quantites of seeds together should be avoided as they quickly heat in bulk.

THE INDIAN TEA INDUSTRY.

TILLAGE OPERATIONS ON TEA GARDENS.

(From the *Indian Agriculturist*, Vol. XXXIV., No. 7, July, 1909.)

About fifty years ago an old London wool-sorter who had been puzzled by many things in the Australian wool

trade determined to go and investigate the matter on the spot. On his arrival at Sydney he made a long tour through sheep stations, and when he returned he wrote to the papers an account of his tour and ended by saying :

"One thing is certain, that the Colonists know nothing upon earth about wool." As this subject of wool had been the only thought day and night of thousands of intelligent men for many years, this saying rather startled the people generally and offended them. But one of the leading squatters asked him to come and see his flocks, which he did, and passed some thousands of sheep through his hands. The result was that the owner said "I begin to think Mr.———is right and that we know nothing on earth about wool." And certain it is that from that time a new era was introduced, and wool was brought to a degree of perfection through the new principles laid down by this gentleman, that nobody had thought of before.

This is exactly what was said about tea planting about twenty years ago by a then very prominent agriculturist. "The whole body of those employed in the cultivation of tea know nothing on earth about vegetation or the first principles of agriculture." Whether there is much alteration, even now, after the advent of the agricultural experts into our midst, is very much a matter of opinion. If a youngster newly out to tea is asked why a garden is hoed so often during a season, his answer will probably be that it is to keep the garden clear of weeds. He knows little more about the matter, and this is not to be wondered at, as at least seventy per cent. of the people engaged in agricultural pursuits at home would return you the same answer. Compared with all the other arts and sciences, agriculture is the slowest in advancing. It was asserted by an agricultural writer last year that a tea planter had very hazy ideas as to why light hoeing produced leaf. He hoed because other people hoed, and he found if he did not hoe he did not get the same quantity of leaf. He might have very safely gone further by saying that it would puzzle experts themselves (himself included) to give a wholly satisfactory answer to the question, why repeated light hoeing should stimulate, again and again, the production of leaf, and, within certain limits the axiom stands good that, "the more hoe the more leaf." This may be taken as a rule of all leaf producers from the homely cabbage upwards, the more cultivation—other conditions being in unision—the larger the amount of vegetable matter in the shape of leaf is produced, if the plants' roots are not mutilated in the process. Whether the chemical action kept going on by the hoe is thoroughly understood or not, the great majority of planters believe in the annual early cold-weather deep hoe.

Every Planter the best Judge.

But there are still a few who, rightly or wrongly, do not believe in a deep hoe at all. Every planter ought to be the best judge and know his own garden best, and there may be cases where a deep hoe may be disastrous. If we may take a hypothetical case (although there are numbers to be found in every tea district), a garden may never have had a deep hoe and have a solid impermeable hard pan existing just below the depth of the usual light hoe. The tea roots have not a great penetrating power when they come into contact with such a hard pan. This is perhaps as much due to there being no inducement in the way of available food as anything else. No matter to what depth the original jungle soil may be loose and friable, when the jungle is cleared and the soil regularly hoed it is bound with our heavy rainfall to form a hard pan just below the depth to which it is hoed. The minute particles of the soil are being continually worked downwards till arrested by the harder soil beneath, where, in combination with any lime particles there may be in the soil, it forms a cemented hard pan. If the roots have not been able to penetrate downwards before this hard pan forms, they get stunted in their endeavours to penetrate it, some of them running along its surface, turning their points upwards towards the cultivated surface and getting the young tips continually cut with the hoe. We have now an established surface-rooting tea garden, with a mass of fibrous root, underneath the branches, one of the most undesirable things in creation for a planter to have under his charge. Such a garden wants deep cultivation in order to give the roots a chance of a longer range in which to search for food, as well as to create a larger supply of available food for the plant. But if this is done the roots are bound to get badly mutilated, and the plants, being already in a weakened state, will either be killed outright or receive such a shock as to render it almost impossible for them to recover.

Trenching.

It has been found extremely difficult to alter the root action of any plant when once it reaches the age of maturity, and the tea plant is no exception to the rule. But in such a case as cited, which is by no means so rare as may be supposed, it has been found that the best

thing to be done in the first instance is to "trench." That is to make a narrow trench about two feet deep in each alternate row of bushes. This trench to be filled in for half its depth with the best soil or compost available—good bheel soil or lime manure is preferable, and if nothing better is to be had the surface soil may be used for the purpose. If there is anything left in the shape of roots at all, they will go down to this, and the better the quality of the buried material the more readily they will go down to it. The rows which are left may be done the same way the following year. In the course of a few years the roots will be induced to take a deep action and allow of that *sine qua non* to successful plateau tea cultivation—the early cold weather deep hoe.

Of course this all ought to have been done early in the garden's history. There never ought to have been a hard pan to cripple the root action of the plant, and, under intelligent up-to-date cultivation, such a thing never would have happened. But owing to scarcity of labour or other causes these things do happen and are always happening. A cure has been pointed out which has, in some cases, answered the purpose. But prevention is proverbially better than cure, and if we always treated our soils, bushes, and coolies on prophylactic principles, we should have little need for cures or tea garden doctors. Every care should be taken during the early years of a garden to keep the soil from forming a hard pan. Deep cultivation is even more necessary during these early years than it is later. The roots of a young tea bush respond readily to inducement to take a deep-rooted action. When once they run into the deeper soil they, in a very great measure, are able to keep the soil free and open enough for the penetration of rain-water and air to follow on its draining away. The gist of all this is—early deep cultivation in order to get a deep-rooted plant, for if it is delayed till the plant s root habit be horizontally formed, it is a most difficult and expensive matter to get things right again.

A Long Drawn-out Experiment.

An experiment has been suggested by our experts to determine the actual kind of light hoeing most suitable for producing the maximum amount of leaf. As this experiment would have to be carried over a period of eight or ten years in order to get reliable data, most planters will be inclined to leave the experiment to "the other fellow." Moreover, it is difficult to see where the advantage would come in generally. It would prove useful for the particular garden experimented upon. But different gardens require more or less different treatment. Environment and circumstance are seldom, if ever, alike on any two gardens. In the absence of such an experiment, which has every likelihood of remaining absent, there are cogent reasons for thinking that the depth of our light hot weather cultivation might be advantageously varied upon most gardens.

We have authoritative opinion that a garden getting five four-inch hoes in the season would be much benefited by the middle one being increased to six inches.

Soil exposed to the atmosphere is "freshened," as it is often termed, by the oxidation of the particles which have been reduced to a lower condition of oxidation during the time they had been covered up. The oxides of iron are examples of this action. When they are exposed near the surface of the sun and air they become fully charged with oxygen. But when buried in the soil they give up scme portion of this oxygen in the several decompositions which take place in the soil and thereby become again reduced to a lower form oxide. In this way they are performing a most important duty as they really become "oxygen carriers" through being alternately buried and exposed during cultivation and in some cases carry ammonia also.

Professor Way's Investigation.

Over thirty years ago Professor Way carried out an investigation into the character of the silicates of alumina, and disclosed truths of immense importance which have not even yet been thorougly understood, and consequently, not fully taken advantage of. He showed the existence of a class of bodies which are termed double silicates. These were silicates of alumina in which part of the alumina had been replaced by an equivalent quantity of some other substance such as lime, soda, potash, or ammonia. Thus we appear to have these double silicates in the soil as silicate of alumina and soda, silicate of alumina and lime, silicate of alumina and potash, and silicate of alumina and ammonia, which is the highest of the series. These substances must be of exceeding importance, and a familiar acquaintance with them is most desirable. Their services have never been mentioned amongst the benefits derived from tillage operations in tea cultivation, but they may be the most important of all in the production of leaf. They have the power, as we have seen, of absorbing ammonia from the atmosphere. Or, perhaps, we shall be putting it more

plainly by stating that (according to Professor Way), the silicate of alumina and potash have a similar chemical affinity for the ammonia of the atmosphere, as hydrate of lime has for carbonic acid. According to the authority already given above, these four double silicates of alumina are formed as follows: Part of the alumina of the simple silicate of alumina has been replaced by soda, lime, potash, or ammonia. Ammonia is more valuable than potash, whilst potash is of more value than soda. Strangely enough the silicate of alumina appears to exercise a similar order of preference. If a double silicate of alumina and soda exists in the soil, and lime should be brought in contact with it, the silicate of alumina gives up the soda and takes up the lime instead, and then we get silicate of alumina and lime. The presence of soda will not enable it to displace the lime as the silicate of alumina has a greater affinity for the lime than it has for the soda. If, however, some potash be added, the lime is given up and the potash is taken into combination, and then we obtain silicate of alumina and potash. But when ammonia comes within the influence of this compound there is so much preference for the ammonia that even the potash loses its position, and then we get silicate of alumina and ammonia formed. This being the highest of the series is a very valuable fertiliser, and when turned down the ammonia is converted into nitrates, the silicate reverting to a lower form and again becoming hungry for ammonia. Its natural craving will again be satisfied when exposed to the atmosphere by the next hoe, and so the never-ending process goes on.

Since writing the above, I notice a member of the Luskerpur Valley Tea Association, in an interesting article, bewails the general ignorance of planters of the science of Arboriculture. If I might venture to offer advice to the member of the Luskerpur Valley Tea Association, it would be, on their starting sessions (they have been in recess a long time now) to procure a number of school primers on the first principles of agriculture. When they have mastered those and think themselves capable of passing the elementary examination as required by the Agricultural Department, Science and Arts, South Kensington, further arrangements might be made for the members making themselves fit to try for an "advanced." By this time they will be better able to understand the subjects they discuss, and also be more able to teach their less fortunate brethren living in the benighted valley further east.

RICE CULTURE ON THE ATLANTIC COAST.

(From the *Louisiana Planter and Sugar Manufacturer*, Vol. XLII., No. 2, January, 1909.)

Elsewhere in this issue we reprint from the *Barbados Agricultual News* extracts from a British Consular Report upon Rice Culture in the United States. The article is quite an interesting one, but, so far as our knowledge of the industry goes, and it comes from considerable experience in it, we believe that this article pertains almost exclusively to rice culture on the Atlantic coast, where it is radically different from rice culture along the coast of the Gulf of Mexico in Louisiana and Texas and along the Mississippi River in Louisiana, where the bulk of the rice of the United States is now produced. The peculiar methods of stretching rice in order to force its growth, making it keep ahead in length or height by keeping water well up to the top of the rice and thus stretching the rice so that it shall get ahead of any opposing grasses, was practised here two or three decades ago, but only to a limited extent. Such practice is usual in South Carolina, but in Louisiana and Texas, and, in fact, along the Mississppi River in the central part of this state, our methods are generally rather ruder ones.

This British report refers to the dry growth, during which time, afer the stretching of the plant and their gaining after stretching sufficient strength to stand up, the water is drawn off entirely from the land and a period of dry growth is established. The forty or fifty days that may be employed in dry growth in South Carolina are practically unknown in Louisiana, and would result in the development of obnoxious grasses, which every effort is made to suppress. The only actual drying of the lands that occur in Louisiana, before harvesting, is when the fields are invaded by crawfish, which at times come in multitudes and destroy the rice fields, perhaps not quite so badly, but somewhat similarly to the multitudes of locusts that attack the grain fields of Kansas at times. In Louisiana the water is generally kept on the rice field from the beginning of the season until harvest approaches, unless it is taken off for the purpose just given to banish the crawfish. Again, the carefully prepared sprout flow that is utilized in the Carolinas is not known here. Rice is planted here just as oats or wheat would be in the North, in what we call our dry culture practice, and in our wet culture practice the rice is sprouted in

sacks by placing them in ditches for some 24 to 48 hours previously to planting. This sprouted rice is then planted in the water and mud of the rice fields and requires that the field should be made dry until the rice is sufficiently advanced to take a little water. All grasses grow so luxuriantly in our alluvial lands that it seems absolutely necessary to pull these grasses out by hand, and " grassing rice " is one of the conspicuous and expensive features of the culture in our alluvial lands. This British Consular Report may be found interesting and will contain some suggestive points to our Louisiana rice planters.

GROUNDNUT TRIALS IN THE WEST INDIES.

(From the *Agricultural News*, Vol. VIII., No. 187, June 26, 1909.)

Recognizing that groundnuts might possibly become a valuable source of profit to small holders and others in the West Indies, the Imperial Department of Agriculture has made several efforts to encourage their cultivation on a more extended scale in many of the islands. These efforts have included the introduction and trial of a number of new varieties of nuts from the United States.

In 1907-8, seed nuts of two new varieties, 'Dixie Giant' (a nut remarkable for its large size), and 'Tennessee Red,' both of which appeared to be promising for West Indian conditions, were imported and trial plantings were made at the Botanic or Experiment Station in St. Vincent, St. Lucia, Dominica, Montserrat, Antigua, and St. Kitt's-Nevis. Unfortunately, however, the results—speaking generally—were not so good as were hoped for.

In the trials made at St. Vincent in 1907, 'Dixie Giant' gave a return at the rate of no more than 5 cwt. per acre, although sown in rich well-manured land. The plants were slightly attacked by a rust fungus. The few seeds of 'Tennessee Red' that were available germinated badly and died out.

At St. Lucia, in the same year, a trial was made with the 'Dixie Giant' groundnut, and 40 pints of nuts were obtained from 3⅗ pints of seed. The nuts were harvested in December, but many of them germinated before they were ripe. This indicates that planting should be done at a time to throw the ripening period into the dry season—between February and May.

At Dominica, where large areas of soil suitable for the cultivation of this crop exist, the two varieties under trial in 1907 gave somewhat better results than in some of the other islands. The 'Dixie Giant' nuts, which were planted early in September, took seventeen weeks to mature, and 6½ lb. of cured nuts from 2½ lb. of seed. In the case of 'Tennessee Red' 3 oz. of seed yielded 1 lb. 3 oz. of nuts. Neither variety was attacked by any pest or disease.

At Montserrat, in the case of 'Dixie Giant' only 4 lb. of nuts were obtained from 2½ lb. of seed. Moreover, many of the nuts contained shrivelled kernels. 'Tennessee Red' did somewhat better.

Fair results were obtained at Antigua with both the imported kinds in 1907. It is believed, however, that the land was unsuitable, being too heavy for the crop. The foliage of the plants was much attacked by caterpillars.

At St. Kitt's, the groundnut plants grew well, and developed a large amount of foliage. Unsatisfactory weather, however, interfered with the proper maturing of the produce.

The experiments with groundnuts were continued in 1908 at the same centres. In addition to the 'Dixie Giant' and 'Tennessee Red,' two other kinds, viz., 'Spanish' and 'Carolina Running,' both imported from the United States, were included in the trials. The 'Spanish' is a very small nut, but one that in the United States is very popular, both among growers, and on the market. It grows well on poor soil, and takes but a comparatively short time to mature its produce. The plants are of an erect habit. 'Carolina Running' is reported to be a prolific bearer in the States, and yields nuts of a fairly large size.

At St. Lucia the four kinds of nuts were planted in October, 1908, but the results proved dissappointing. 'Carolina Running' was the only variety which germinated well and produced a crop which was harvested on February 11, 1909. The yield was at the rate of 504 lb. per acre.

The report on the trials made at Dominica states that the soil on which the groundnuts were grown, was carefully prepared beforehand. With the exception of the plot on which the 'Dixie Giant' nuts were planted, the soil was very light and fine in texture, which offers the most favourable conditions for this crop. The land planted with 'Dixie Giant' nuts was of comparatively heavy nature, and this, no doubt, had a detrimental effect upon the yield of nuts obtained.

All the four kinds of nuts were sown in July. The 'Spanish,' 'Carolina Running' and 'Tennessee Red' varieties

were reaped towards the end of November, while the 'Dixie Giant' nuts did not mature till about a fortnight later. The 'Spanish' variety did best, showing a yield at the rate of 1,940 lb. per acre. This was followed, in the order named, by 'Carolina Running' (1,137 lb. per acre), 'Tennessee Red' (459 lb. per acre), and 'Dixie Giant' (335 lb. per acre). It is mentioned that the small nuts of the Spanish variety sell in Dominica much more readily than hose of larger kinds.

At Montserrat the four kinds of nuts were planted on June 26 and reaped in the last week of October, so that only four months were occupied in coming to maturity. This was probably owing to the dry weather that was experienced during the season. The yields were poor, 'Carolina Running' giving the highest return, which was at the rate of 889 lb. per acre. 'Tennessee Red' yielded at the rate of 400 lb., and 'Spanish' at the rate of 364 lb. per acre. 'Dixie Giant' failed to germinate at all.

At Antigua, plots were planted with each of the four varieties. 'Dixie Giant' gave the best return—at the rate of 960 lb. per acre. 'Carolina Running' yielded at the rate of 640 lb., 'Spanish' 440 lb., and 'Tennessee Red' 440 lb. per acre. It is mentioned that in these experiments, the plants of the 'Carolina Running' variety covered the ground much better than any of the others.

Mr. Shepherd has sent in a report on the groundnut trials made at St. Kitt's in 1908. The same four kinds of nuts were planted as in the other islands to which reference has already been made. It is unfortunate, however, that the varieties, 'Spanish' and 'Tennessee Red' were severely attacked by a fungus, and as a result only a poor crop of nuts was harvested, the yield being at the rate of about 300 lb. per acre. In the case of 'Dixie Giant' the nuts planted showed very poor germination, and rotted in the ground as if attacked by a fungus disease, although they appeared to be sound at the time of planting. Much better results were obtained with the 'Carolina Running' variety. The seed nuts showed good germinating power, and the ground was soon well covered by the vines. The nuts took from five to six months to mature, and gave a yield of nearly 1,500 lb. per acre. A local variety of groundnut planted for purposes of comparison, showed a crop return at the rate of about 2,000 lb. per acre.

Mr. Shepherd points out that in the experiments made at St. Kitt's, none of the imported varieties have yielded a return superior to that given by the local nut, but adds that some of the new kinds evidently possess certain very desirable characteristics not found in the local variety. It is apparent that there is room for selection work in this connexion, with the object of bringing about increased resistance to disease. Further experiments are to be carried out at St. Kitt's this year.

The four kinds of groundnuts in question were also tried at Nevis last year. 'Carolina Running' and 'Spanish' did best, giving yields respectively of 1,400 lb. and 810 lb. per acre. Both these varieties matured in slightly less than four months. 'Tennessee Red' germinated fairly well, matured early, and yielded a crop at the rate of 360 lb. per acre. The 'Dixie Giant' variety failed to do well, many of the nuts rotting before coming to maturity. The total return obtained was at the rate of no more than 120 lb. per acre. A local variety, grown under similar conditions, gave a yield at the rate of 570 lb. per acre.

HOW JAVA CAME BY HER PRESENT EXCELLENT SUGARCANE.

By H. C. PRINSEN GEERLIGS.

(From the *Louisiana Planter and Sugar Manufacturer*, Vol. XLI., No 18, October, 1908.)

In the year 1892 a mysterious, up to that time still unheard of, disease befell the sugarcane plantations in the most western part of Java and gradually spread in an eastern direction, crawling along every year till at the end of 1892 all the sugar-growing districts of the island were infested with it. The symptoms of the disease were chiefly a stoppage of the growth after a few months' vegetation and a considerable development of secondary stalks and ærial roots. These secondary roots were in their turn also attacked by the disease and remained short too, so that the whole stool instead of representing the usual aspect of a stately group of long stalks, crowned with green stuffs of leaves, resembled the crumpled bunches of the citronella grass, after the Javanese name of which, "sereh," the disease was called sereh-disease. Of the symptons mentioned, of course, that respecting the stoppage of the growth is the most serious one, and in fact it decreased the yield of a diseased field in such a way as to render it practically valueless. It is a happy circumstance that the disease first commenced in one part, and only very slowly proceeded

eastward, and thus allowed the planters to take their measures. If it had struck the whole of the island at the same time, very likely it would have destroyed our sugar cultivation right out, the more so, as at the same time a serious crisis in sugar prices prevailed, which was apt to endanger the existence of many sugar estates even without the aid of the disease. Now it fortunately took ten years before the sereh disease had spread throughout the whole island, and the planters made a happy use of that respite to bethink themselves of remedies to combat it.

While the western part of the land was infested, the middle and eastern parts still were free and could spare a continuous stream of sound cane tops, which were used for replanting the attacked cane fields in the western parts; but as the disease slowly but uninterruptedly spread eastward, the available amount of sound tops decreased yearly, while the area, wanting them, increased accordingly, so that everybody could prophesy that this way of combating the dreaded disease was only a palliative and no remedy. In that time the Java planters sought the aid of science, and established three experimental stations in different parts of the island, with the chief object of suggesting means to save their industry from the threatening ruin. The scientists attached to the stations, chiefly botanists of already fixed European renown, started work at once, and besides investigating into the real cause of the disease, looked out for practical ways to stamp it out or to avoid it. A great deal of cane varieties from every cane growing country were brought over to Java, propagated and planted in the different estates, and, in fact, among the hundred and odd of those varieties a few proved in the first years after their introduction to be of great value; they were immune against sereh and produced yields which were by no means inferior to those obtained with the Black Java or Cheribon cane. At the same time the planters wanted to continue the way of planting every year afresh with sound tops from parts of the land, where the sereh had not yet appeared, as they did not like to leave the variety which had given them every satisfaction up to now, and feared the new varieties could some day or other degenerate and become in their turn victims of the same or another disease. As we saw before, the sugar growing parts of the land became gradually infested, so that it soon became impossible to procure sufficient seed for the estates from the tops of still existing sound cane fields. Therefore, the sugar estates selected in the mountains and similar remote spots, where no sugar industry existed, fields where they planted cane for seed only. Sound tops were carefully selected, planted with much care in a mountainous region, far from every infection by other cane and raised canes, which were cut six or seven months after planting, and used for seed in the plains for the planting of cane fields. As it soon appeared that ratoons became unfailingly infected with sereh and did not yield even moderately good crops, where the plant cane had produced a good one, the planters were compelled to keep off from growing ratoons, and since the last fifteen years no ratoons are kept in Java, and all of the sugar cane is planted every year again. The introduction of the varieties from other countries and the system of nurseries in remote parts together co-operated in expelling the disease, but at what cost!

The new varieties gradually fell off in quality and could not be relied upon, which always gave a feeling of uneasiness for the future, while the expense of the nurseries and the transport of tops from them were too heavy to be continued. In many cases the expenses for the tops even amounted to one-fifth of the whole cost price of the sugar, and this item became so heavy that it swallowed all of the profit, while at the same time the danger remained that also the mountainous parts one day or other would be attacked and excluded from the raising of the seed. In the meantime, however, the scientists had continued their researches and raised cane from seeds; first in a haphazard way, but afterwards on a scientific and systematic footing. At the outset some arrows were cut, spread out on carefully prepared soil, and the resulting tiny cane plants were nursed and planted out in the field. Every plant was analysed, weighed, inspected and observed, and the inferior plants steadily removed so as to keep only the selected good ones. This selection was so rigid, that from the thousands and thousands of plants only some two or three came into use. This terrible waste of time and work induced some investigators, especially Messrs. Moquette, Kobus and Bouricious to select canes of varieties which promised much in some direction or other and to cross-fertilize their flowers, so that, not as formerly, fertilization with some unknown pollen was secured, but the fertilization was effected with carefully selected pollen of especially chosen fathers. The results were brilliant, and Java came into possession of families of sugarcane which surpass in every point

the old canes ofyore. Now there is such a variety of good and rich cane that every estate owner can choose the variety which best suits the quality of his land, or his climate, and even suit the time when he wants to harrvest them. He can choose early ripening varieties for the beginning of his crop, and late ripening ones for the end, and so dispose during the whole course of his grinding time of green, fresh and sound cane at its highest point of sugar content and vigour. Not contented with the results already obtained, Mr. Kobus is steadily busy breeding new varieties in order to replace the existing ones if perchance these might in their turn degenerate or become attacked by some new infectious or other disease.

This brilliant success accounts a great deal for the excellent Java returns of the last few years, and we can safely say that the sereh disease has not only totally disappeared, but has had the unexpected advantage of providing Java with a supply of canes much better and more resistant against drought or wet weather, against insects and disease, than has any other country, and, moreover, has the experience in how to create new varieties if the existing ones fail. It is obvious that only tropical countries, where the cane attains its full maturity and flowers every year, can obtain the same results, and that for non-tropical countries the raising of new varieties will meet with much more difficulty.

TIMBERS.

TREE PLANTING AT ANTIGUA.

(From the *Agricultural News*, Vol. VIII., No. 185, May, 1909.)

Compared with many other of the West Indian islands, Antigua is singularly destitute of woodland, or even of small groves of trees. This lack of suitable vegetation tends to give the hillsides and waste places a somewhat barren appearance, and the lack of shelter that would be provided by extensive wooded areas increases the tendency of the island to suffer from drought. Tree planting on a large scale would not only improve the appearance of the landscape, and provide a source of timber and fuel, but would also be of advantage in providing shelter belts of woodland, and have a certain amount of influence in modifying the dryness of the atmospheric conditions, and economising the water supply by reducing evaporation.

Some efforts in this direction have been made by the Agricultural Department, and two afforestation plots have been started in the neighbourhood of the Botanic Station. One is situated to the north of the Station, and is about $1\frac{1}{2}$ acres in extent, The second plot is to the east of the station, and about $\frac{1}{4}$-mile distant. It is some $2\frac{1}{2}$ acres in area.

The plots were established in 1902; the soil is poor in both, and they are fully exposed to the prevailing trade winds. They had received very little cultivation at the time of planting, and are similar in character to the bare hillsides in the island, so that from the progress which the trees have made, some deductions can be drawn as to the results which would probably follow tree planting on other waste spots.

The plot situated to the north of the Botanic Station has made the best growth, and the shelter that it at present affords to the Station has had a markedly beneficial effect. In the year 1907-8, the growth of the trees in the plot to the east of the Botanic Station showed marked improvement. It would appear, however, that it is advisable, in planting trees on land where the soil is poor and the situation exposed, to give a greater amount of cultivation during the first years of their growth than was given to the two plots attached to the Botanic Station. The results so far attained also indicate that expenditure, within reasonable limits, on starting woodlands in bare districts of these islands will, in course of time, be amply repaid, in view of the advantages to be derived from their establishment.

In 1905, two wind-breaks of forest trees were planted to the north-east and south-east of the Antigua Botanic Station. These have made good growth, and now afford considerable shelter to the gardens.

The efforts that have been made on Arbor Day in each year to encourage an interest in planting out young trees, on the part of all classes of the community, have also had good effect. In this way laige numbers of young trees have been planted in the Victoria Park, and at other spots in and around the town.

The example which has thus been set would appear to have encouraged a considerable amount of interest in tree planting at Antigua, and numerous enquiries are received at the Botanic Station on the subject. Mr. Thomas Jackson, Curator of the Station, has lately sent in some interesting and

useful notes on the matter, the points of which are here reproduced :—

It is likely that the planting of trees suitable for timber purposes will receive more attention at Antigua in the future than it has done in the past. There is, naturally, a good local demand for timber, and the construction of 18 miles of railway, involving the utilization of a large quantity of timber for sleeper purposes, will naturally increase this demand. At present the amount of timber grown at Antigua is very small, but efforts are already in progress which indicate that the home supply will in time tend to increase.

In the West Indies, as in other countries, the great drawback to any scheme of afforestation is the length of time that must elapse before any return can be obtained. This difficulty is inevitable at the start, however, and a certain number of years must necessarily elapse before an area of newly-planted woodland returns the outlay that has been expended upon it, and becomes self-supporting.

In view of this fact, it becomes a matter of chief importance, when any scheme of tree planting is to be carried out, to choose those species for planting which are likely to give an early return, and to be in good demand for special purposes.

In his paper, Mr. Jackson enumerates a list of trees which might be expected to do well at Antigua. Special reference is made to the species *Eucalyptus rostrata*, or 'Red Gum.' This grows satisfactorily even under somewhat unfavourable conditions. At the Botanic Station there is a sample of this species, which, although no more than seven or eight years old, and growing in poor, shallow soil, has a height of 35 feet, and a circumference of 3 feet 8 inches at 10 feet from the ground. Although the trunk of this specimen divides into four at about 12 feet from the ground, each stem possesses serviceable timber. *Eucalyptus rostrata* is well known as a particularly hardy species, and thrives well under a fairly wide range of conditions. It stands drought well. The wood of the tree is durable both in the air and when buried in the soil. Pieces of 'Rek Gum' timber which have been under the soil for two years at the Antigua Botanic Station are still in an excellent state of preservation. In colour the wood varies from light red to very dark red. If rapid growth and good quality of timber are required, *E. rostrata* can be recommended.

Other species of Eucalyptus, which are suitable for planting in parts of the tropics, and yield useful timber, are *E. citriodora*, *E. corymbosa*, *E. teretecornis*. *E. cornuta*, *E. crebra*, and *E. microtheca*.

At the Antigua Botanic Station there exist, in addition to *E. rostrata*, specimens of *E. citriodora* and *E. cornuta*. Both of these have an erect growth. The wood of the former makes a useful timber; it has a close grain and splits readily. *E. cornuta* stands drought well. Its wood is tough, hard, and elastic.

Estate owners and others who may think of planting up waste lands, or at least of increasing the number of trees on their estates, may usefully make selections from the following list of timber trees :—

Lignum-vitæ (*Guaiacum officinale*). A slow-growing tree yielding wood which is exceedingly dense, hard, heavy, and tough. This is extremely useful for a variety of turnery purposes.

Galba (*Calophyllum Calaba*). A tall and somewhat quick-growing tree which reaches a diameter of 4 or 5 feet. The wood is durable, and is suitable for mill rollers, frames, and for shingles, etc. It bears exposure well.

Mammee apple (*Mammea americana*). This tree reaches 40 to 60 feet high, and yields durable timber that is adapted for use in exposed situations. The mammee apple tree is not common at Antigua, and it is probable that it would not grow well in the drier parts of the island.

The 'red mangrove' (*Rhizophora Mangle*) and the 'black mangrove' (*Avicennia nitida*) both grow in swamps, and the wood in each case is valuable for piles, posts, etc.

White cedar (*Tecoma leucoxylon*). This tree is common at Antigua. The wood is used largely in house-building, and is valuable for piles, posts, and in making shingles.

Logwood (*Hœmatoxylon compechianum*). This tree, which seldom reaches more than 20 feet high, is also common at Antigua. A very serviceable hedge is formed by setting out the young plants closely in rows. The wood is hard and suitable for posts and cabinet work. It is also of considerable value as a dye-wood.

Cashaw (*Prosopis juliflora*). The cashaw grows to as much as 30 feet in height, but its diameter is seldom more than 1 foot. The timber is very strong and durable, suitable for railway sleepers, fence posts, etc. The pods of the cashaw, when dry, form a good article of fodder, and are greedily eaten by stock of all kinds. The wood also makes excellent fuel.

Bastard mahogany, walunt or angelin (*Andira inermis*). A large and hand-

Photo by H. F. Macmillan.

TURNERA ELEGANS.

some tree, somewhat common in the southern part of Antigua. It is of erect growth, and with a trunk from 1 to 2 feet in diameter. The wood is strong and hard, lasts well in water, and is suitable for turnery purposes.

Woman's tongue (*Albizzia Lebbek*). The wood of this tree is fairly durable and polishes well. It is used in making furniture, boat building, and for general purposes.

Red cedar (*Cedrela odorata*). On good soil this tree frequently attains a height of from 40 to 60 feet, with a trunk diameter of from 3 to 4 feet. It is quick-growing, the wood being open-grained, but soft and porous. Cedar wood is in request for furniture making, especially wardrobes, shingles, interior house-work, etc. The drier parts of Antigua would perhaps be unsuitable for this tree.

Casuarina equisetifolia. The Casuarina is a straight and quick-growing tree, which yields good timber, that is found especially useful in making cattle yokes.

Locust (*Hymenœa Courbaril*). This tree has a trunk which reaches up to 5 feet in diameter. The wood is tough and somewhat resembles mahogany, but is harder. It is used for cabinet and furniture work. It is liable to rot in the ground.

White-wood (*Terminalia Buceras*). The White-wood is a large tree that yields timber which is useful for a variety of purposes. This is one of the best woods for shingles. It is very durable in water.

Other trees suitable for planting in Antigua, and which yield wood of value, are the following :—

Mahogany (*Swietenia Mahagoni*), Sapodilla (*Achras Sapota*), Star apple (*Chrysophyllum Cainito*). Almond (*Terminalia Catappa*), Torch wood (*Tecoma stans*), and the sea-side grape (*Coccoloba uvifera*), which grows on indifferent lands near the sea-shore.

It may also be added that the wood of the mango and acacia makes excellent fuel.

HORTICULTURE.

TURNERA ELEGANS.

BY H. F. MACMILLAN.

(*Illustrated.*)

Among the best flowering plants for gardens in the Tropics must be included *Turnera elegans*, also known as *T. trioniflora*, of the natural order *Turneraceæ*. It is a small shrubby perennial, native of Brazil, with thin wiry straggling branches, seldom exceeding two feet in height. The exact date of its introduction into Ceylon is not recorded, but the plant is known to have been grown at Peradeniya previous to 1845.

The flowers are of a pretty creamy white colour, with a dark-purple "eye" formed by the coloured base of the petals. The flowers, which are sessile or very shortly stalked, are produced singly in the axils of the upper leaves, to the stalks of which they are adherent ; they open in the morning and close at noon, the petals assuming a twisted form. The plant is in flower throughout the greater part of the year, but more particularly in the dry season, and when grown in a mass, as at Peradeniya, is very attractive. The leaves when bruised are strongly scented, somewhat resembling sorrel. A peculiarity of this family, which is shared by the plant under notice, is that the flowers of some of the species are what is termed in botany dimorphic and heterostyled ; that is, the flowers of one plant are long-styled, with stamens half-way up the tube of the corolla and the stigma and its mouth ; while on another plant the flowers are short-styled, with the stigma half-way up and the stamens at the mouth. This arrangement is a provision of Nature for effecting cross-fertilisation, which in this case is brought about by the aid of bees or butterflies.

The plant is propagated by division, cuttings, or seed. It thrives best in a rich free soil in partial shade, and will respond well to a liberal application of well-decomposed manure or leaf-mould, which may be given as a top dressing and forked into the soil. The plant bears transplanting badly, and when this operation is undertaken the shoots should first be pruned well back, the plants being afterwards copiously watered and shaded.

PLANT SANITATION.

INSECTS ASSOCIATED WITH THE COTTON PLANT IN CEYLON.

BY E. ERNEST GREEN,

Government Entomologist.

The insect enemies of the cotton plant in Ceylon have hitherto received little notice, owing to the merely spasmodic attempts that have been undertaken to cultivate this plant until the last few years. The recent demand for British-grown cotton has, however, drawn fresh attention to the possibilities of cotton as a profitable industry in the drier parts of the Island. Even now the area under cultivation with this product is limited to a few hundred acres. But our very short and limited experience has been sufficient to show us that the cotton plant is remarkably subject to insect enemies of many kinds, and that—if the industry is to be a success—we must be prepared to fight these enemies from the very commencement.

The rapidity with which this plant becomes infested by its particular enemies is most remarkable. A small plot was opened on the Peradeniya Experiment Station in the present year for the first time. As far as I can learn, no cotton had previously been grown in the neighbourhood. But the very first crop raised was so badly infested by boll-worms and cotton-stainers as to be practically valueless. One of these boll-worms (*Gelechia gossypiella*) is not known to breed in any other plant, and is consequently dependent upon the cotton for its existence; the other pests frequent allied plants, but are seldom found in such abundance as on the cotton.

We have, fortunately, no such alarming pests as are prevalent in the American States, where the notorious 'Boll-weevil' alone has been engaging the attention and taxing the energies of the economic entomologists of the United States for more than ten years. To give some small idea of the importance of this pest, I will quote from a recent circular of the U. S. Department of Agriculture, which states that "a conservative estimate shows that since the weevil invaded this country it has caused a loss of 2,550,000 bales of cotton, at a value of about $125,000,000," —a sum equivalent to twenty-five million pounds sterling.

But our comparative immunity from such overwhelming enemies is rather apparent than real. If we had the same acreage under cultivation as there is in America, and if the greater part of that acreage was as badly attacked by our local boll-worm as was the half-acre plot on our Experiment Station, the total loss might rival, or even exceed, the figures just quoted. Then, with the gradual extension of the area under any product, it is the usual experience that fresh pests will come into prominence, attracted by a constant and unfailing supply of food.

However, the consideration of such figures must not be taken too seriously. An immense incalculable loss is always taking place, with every product, through the depredations of various pests; and yet enough remains to repay the cultivator. It has been estimated that, if every sparrow in England consumed one farthing's worth of corn during the year, the annual loss throughout the British Islands would amount to over a million pounds. We might thus pile up a stupendous total of loss to the British farmers during the last century. But corn is still grown and will continue to be grown with profit. In the same way, if the annual loss of leaf through our various tea pests—shot-hole borer, helopeltis, tea-mites, and sundry caterpillars—could be put into figures, it would probably scare a considerable number of worthy people at home, whose capital is invested in this product.

It will be sufficient to realize that the cultivation of cotton will not be merely a matter of putting in the seed and harvesting the crop in due course; that there will be numerous enemies to be contended against; and that careful attention will be necessary at all stages of the plant.

In the time at my disposal, it will be impossible to offer a treatise upon the particular treatment of all these enemies, but, to assist in the recognition of them, I have enumerated and briefly described some of the principal insects associated with the cotton plant that have come under my observation.

The most important of these are the boll-worms, of which we have two species in Ceylon.

1. The 'Pink Boll-worm' (*Gelechia gossypiella*) is a small coral-pink maggot-like caterpillar that feeds among the ripening seeds of the pod. The eggs are laid singly on the leaf-like bracts at the base of the boll, and the young caterpillar bores its way into the pod. This tunnel is apparently enlarged and kept

open to ensure a supply of air. Infested pods can be recognized by the presence of this circular hole, usually situated near the base. The fully grown caterpillar may either spin its cocoon amongst the lint, or it may desert the boll and descend to the ground, where it pupates amongst the loose earth. It finally emerges as a small dull-coloured grayish-brown moth with narrow wings, having an expanse of from ⅜ to ¾ of an inch. Lefroy states that, in India, there are six broods in the year, and that—in the colder districts—the caterpillar hibernates in the seed. Bolls that have been attacked by the insect usually open prematurely and do not ripen their lint, which remains in a more or less matted condition. The premature splitting of the bolls also makes way for the entrance of cotton-stainers (described below) which complete the mischief.

2. The 'Hairy Boll-worm' (*Earias fabia*). This is a rather larger caterpillar, very pale green, with some yellow spots and darker markings on each side. The hairs are sparsely scattered over the body. It tunnels not only into the young bolls but also into the tender stems of the plant. Like the 'pink boll-worm' it may pupate either inside its tunnel or on the surface of the ground. The moth is a very pretty little insect; the front wings creamy white, with a bright green wedge-shaped band extending through the middle of the wing from the body to the outer margin. It is a more thick-set moth than that of the previous species, and has an expanse of ⅞ of an inch. This species of boll-worm has been recognized only recently in Ceylon, but is a well known pest of cotton in India where, according to Lefroy, it has about eight broods in the year. The resulting damage is similar to that caused by the pink boll-worm.

For remedial treatment, these two species may be considered together. The collection and destruction of the wormy bolls which—after a little practice—are easily recognized by the presence of the small circular entrance to the tunnel, or by the premature splitting of the pod, will greatly reduce the later broods and so lessen damage to subsequent crops. But this will not save the existing crop which has already been damaged. The similarity of the mode of attack to that of the Codlin moth of the apple, suggests the possibility of a similar preventive treatment, namely, by spraying with Lead Arsenate as soon as the fruit begins to swell. The young caterpillars, in attempting to tunnel into the boll, will be poisoned by the superficial layer of arsenic.

As already mentioned, Mr. Lefroy records the hibernation of the pink boll-worm in the cotton seed in the colder parts of the plains of India. It is doubtful if any hibernation would occur in the warmer districts, or in Ceylon. And yet it is difficult to account otherwise for the sudden appearance of the pest in newly-planted and isolated fields. Mr. Lefroy informs me that—as a precaution—he recommends the fumigation of the seed before planting. Imported cotton seed is now being fumigated at Colombo before delivery; but if hibernation in the seed is of more genera- occurrence, it would be equally advisl able to fumigate local seed, or to disinfect it in some other manner.

Next in importance to the 'boll-worms are the 'cotton-stainers.' These belong to the bug tribe (the Hemiptera) and are armed with sharp sucking proboscis. The cotton-stainers earn their name through the frequent discoloration of the lint either from their excreta or by the juices of their bodies when accidentally crushed. The following four species attack our cotton in Ceylon.

3. The 'Dusky Cotton-Stainer' (*Oxycarenus lætus*). This is a very small dingy little insect, scarcely more than one-eighth of an inch in length; the body and legs dull black; the wings semi-transparent and folded close across the back. This bug swarms in the cotton bolls after they have opened, and is, I believe, itself responsible for the premature opening of many of the bolls. It also punctures the green pods, causing them to dry up and split. It occurs in countless thousands in the cotton fields. As many as a hundred individuals may occupy a single infested boll. I have not seen the eggs, but Mr. Lefory states that they are laid amongst the lint, close to the seed, in batches of six to ten. He describes the eggs as cigar-shaped, about one-thirtieth of an inch long, of a bright yellow colour at first, but turning bright orange shortly before hatching. The young insects are miniature editions of the parent, but lighter in colour and wingless.

4. The 'Ceylonese Cotton-Stainer (*Oxycarenus lugubris*) is very similar to the preceding species, but may be distinguished by its black wings, each with a creamy white triangular spot near its base. The young insect is of a brick-red colour, with a white band across the base of the abdomen. It occurs only in Ceylon. Its habits are similar to those of its 'dusky' relative.

5. The 'Banded Cotton-Stainer' (*Dysdercus cingulatus*). This is a larger insect, more than half an inch long. The general colour varies from grayish-

ochreous to bright red. The extremities of the wings are black, and form, when folded together, a conspicuous black diamond-shaped patch. There are also two black rounded spots situated just in front of the terminal patch. A narrow white transverse band forms a collar immediately behind the head. The under-surface of the body is conspicuously banded with white.

Lefroy records that "the eggs are laid in a loose mass under the surface of the soil, usually in a crack or depression, which the female covers with earth after depositing the eggs. Each egg is round, of a light yellow colour; between 50 or 60 are laid by each female. In less than a week the eggs hatch to small active red insects."

The 'banded cotton-stainer' does not confine its attentions to the cotton plant, but is found commonly upon Hibiscus and numerous other plants. The insects congregate on the cotton bolls, sucking out the juice and even damaging the contained seeds, especially after the bursting of the pod.

5. The 'Large Cotton-Stainers' (*Serinetha abdominalis* and *S. augur*). I have found both of these insects sucking the seeds of burst cotton pods. They differ from the last species in their slightly larger size (from five-eighths to three-quarters of an inch long), and in the absence of the white collar and of the two black spots on the wings. They may be distinguished from each other by their colour, *abdominalis* being ochreous above and blackish beneath; while *augur* is red above and below. They each have a large lozenge-shaped black patch at the end of the folded wings.

The remedy for all the different cotton-stainers is to reduce their numbers by every possible means. This may best be effected by shaking the branches over a sheet, when the insects fall off and may be collected and thrown into vessels containing kerosene and water. If this is carried out systematically at the commencement of the crop, much trouble will be avoided later on. If—as is usually the case—some of the bugs remain in the lint after it has been picked, they will quickly remove themselves when the lint is spread out in the hot sun.

Several Scale-bugs (*Coccidæ*) occur with considerable frequency on cotton stems, and must weaken the vitality of the plants to a certain extent. The three more common species are representatives of the three larger families of scale-insects, namely, the 'hard scales' (*Lecaniinæ*), the 'mealy-bugs' (*Dactylopiinæ*) and the 'armoured scales' (*Diaspidinæ*).

6. The 'Black Bug' (*Lecanium nigrum*) is a small black limpet-like scale, with a hard shiny shell beneath which the countless eggs are deposited. The newly-hatched insects—which are almost invisible to the naked eye—swarm on to the smaller twigs and branches, where they attach themselves by their fine hair-like proboscides for the rest of their lives. They are at first very pale pinkish yellow; but during growth, they gradually become darker, the pigment commencing in the form of a network of reddish brown lines; finally becoming black or deep chestnut-brown.

7. The 'Filamentous Mealy-Bug' *Dactylopius virgatus*) becomes conspicuous on the younger stalks by the masses of cottony or silky secretion with which it surrounds itself. The adult insect is soft and fleshy and of a pale yellowish or pinkish colour which, however, is almost completely obscured by a covering of white mealy powder.

8. *Hemichionaspis aspidistræ.* It is difficult to find a suitable popular name for this insect. It might be called the 'Scurfy Scale,' but that name has already been adopted for a different species that occurs in America. The Americans term this species the 'Fern Scale,' from the frequency with which it occurs on cultivated ferns in that country. In Ceylon, the insect appears to be equally abundant upon fifty or more different plants of widely different orders,

It affects the stems of the plant. The females are very inconspicuous, being covered by a thin scale of a very pale reddish-brown colour which closely resembles the tints of the bark. But the males are concealed beneath a snowy-white tricarinate scale, and—having the habit of congregating together by themselves—form conspicuous white scurf-like patches on the stems.

It is questionable whether any effective remedial measures against these scale-insects would repay the cost. They can be killed by spraying with kerosene emulsion. But the effective life of the plant is comparatively so short that the bugs have not sufficient time to increase to a really dangerous extent before the old plants are uprooted and burnt together with all the insects upon them.

Of the remaining insects associated with the cotton plant in Ceylon, it will be sufficient to speak very shortly. They are not, at present, of sufficient importance to necessitate special remedies.

9. *Helopeltis antonnii.* I have, on one occasion, observed a few specimens of this insect on the cotton plant. But as the field was in the immediate vicinity

of a cacao plot, it is probable that they had wandered from their usual habitat. However, by confining them with young shoots of cotton, I found that they would feed readily upon this plant, causing the characteristic brown spots that are always associated with the work of this pest.

The insect itself is almost too well known to require description. It is one of the leaf-sucking bugs, a slender insect, with long antennæ and legs, and popularly supposed to resemble a mosquito. It may be recognized by the presence of a knobbed spine (somewhat like a drumstick) standing up erect from between the bases of the wings.

10. *Callicratides rama*. A pale green bug, with hyaline wings, allied to and having the same habits as the Helopeltis. A few examples were found upon cotton bushes on the Experiment Station, Peradeniya.

11. *Zeuzera coffeæ*. The 'Red Borer.' This boring caterpillar is gradually proving itself to be more or less omnivorous. I have a single record of a cotton stem tunnelled by the red-borer.

12. *Sylepta multilinealis*. The 'Cotton Leaf-Roller.' The small greenish caterpillars of this moth are often present in some numbers on the cotton plant; rolling up the leaves and feeding upon their infolded edges. The resulting moth is a pretty insect, with pale creamy wings upon which is an intricate net work of delicate brown lines. The expanded wings measure a little over one inch.

13. *Eupterote geminata*. The hairy caterpillars of this moth sometimes occur in bunches on the branches. They feed at night and rest motionless during the day. They should be handled with caution as their hairs are capable of causing painful irritation to a delicate skin. The moth is of an ochreous yellow colour, with an inconspicuous brownish line extending across each wing, and two or three brownish spots between that line and the outer margin. The body of the moth is very furry. The male measures nearly two inches across the wings; the female, two and a half inches.

14. *Gracilaria* species. A tiny caterpillar that feeds beneath the cuticle of the green stems. Specimens of this insect were received from the Kurunegalla district; but they died before completing their transformations.

15. *Psiloptera festuosa*. A beautiful bronzy metallic-green beetle, one inch in length, belonging to the family *Buprestidæ*. Collected on the cotton bushes at the Experiment Station, Mahailluppalama. The larvæ of this family of beetles are all borers; but as no damage to the cotton was observed, it is probable that the beetles had their proper home in the surrounding jungle.

16. *Geocoris tricolor*. A tiny stout-bodied bug, with broad head and prominent eyes. A number of these insects were captured on the cotton plot at Peradeniya. Bugs of this genus are believed to be predatory upon other insects. In this case they may have been doing good work amongst the swarms of the Dusky Cotton-Stainer.

17. Flower Beetles. Numerous minute beetles, of several species, will usually be found frequenting the blossoms of the cotton. They congregate amongst the stamens and may possibly assist in the fertilisation of the flowers by carrying the pollen from one blossom to another.

In conclusion, I should like to emphasise the importance of treating the cotton plant strictly as an annual. The best way to check all the insect pests that attack it, is to uproot and burn the plants immediatly after the principal crop. During the intervals, not a single cotton plant should be permitted to remain in the ground. If this system is conscientiously carried out, most of the insects that are dependent upon the cotton plant for their livelihood will be destroyed or starved out before the appearance of the next crop. A second or even third crop might perhaps be gathered from the same plants by leaving them in the ground; but these later crops will be much more severely punished by pests of all kinds, and will be a source of danger to fresh crops that may overlap the old. For the same reason, perennial (or tree) cottons should not be cultivated anywhere in the vicinity of the annual varieties.

As some of the cotton-stainers (and probably some other cotton pests) frequent the 'Silk-Cotton' trees (*Eriodendron* and *Bombax*) when they are in fruit, these trees also should be prohibited on a cotton plantation.

Recent experiments in the United States have proved that it is not only important to destroy the old bushes, but that they should be destroyed immediately after the collection of the crop, to allow of the longest possible interval between two successive crops. A delay of three weeks increased the percentage of boll-weevils that survived the interval, from 3 to 15; seven weeks' delay increased the number of survivors to nearly 22 per cent.; ten weeks' delay brought the figure up to 28 per cent.; and the retention of the old plants for three months resulted in a percentage of 43½ survivors.

A RIPE ROT OF MANGOES.

BY T. PETCH, B.SC., B.A.

Specimens of mangoes have recently been sent in from the Batticaloa district, with the information that they usually developed black spots when ripening, and had lost the flavour which characterised them in previous years. The tree was a grafted mango, imported from India, the fruits being of the rupee mango type and above the average size. The grower stated that the fruits were gathered before they were ripe, in order to avoid the ravages of squirrels, and were kept closely packed for a few days until they acquired a golden colour. The ripening began from the stalk end of the fruit, that end becoming pale yellow and soft while the remainder of the fruit was greenish. In previous years the fruits had been sweet, but now, when apparently ripe, they were sour.

Two specimens were sent. One of them showed a few circular black spots scattered over the surface, and was turning pale yellow round the stalk, the other was still green. The black spots did not extend through the rind, some of them were superficially cracked, and contained a dark-brown irregular mycelium in the cracks, but this had not spread into the fruit. At first sight, therefore, these spots appeared to have no connection with the change of flavour, but another explanation of them presented itself afterwards. On cutting open the fruit, the pulp below the pale yellow rind was found to be watery looking, contrasting strongly with the firm orange flesh under the greenish rind. This watery tissue extended all over the top of the fruit, and down on both sides of the stone. Microscopic examination proved that this part of the fruit was permeated by a coarse hyaline mycelium, spreading in all directions between the cells. The cells still contained a large number of starch grains, a fact which shows that ripening had not been completed, since in the course of the ripening process the starch grains are converted into sugars. It is quite clear, therefore, that the supposed ripening is not a ripening but a rot caused by a fungus, and that the acid flavour is due to the incomplete conversion of the starch grains in the immature fruits. The fungus enters the fruit through the stalk and spreads in all directions through that end of the fruit, and therefore that part appears to ripen first. When it reaches the top of the stone it travels down both sides of it much more rapidly than in the fleshy parts; the rot of the tissue round the stone in this case made it possible to shell out the latter after the manner of a plum stone. This fruit was split into two parts longitudinally, and the halves were placed in a glass dish. By the next morning it had developed an abundant covering of greyish black mycelium over all the watery yellow parts but not over the firm orange yellow tissue. This confirmed the result of microscopic examination, that the fungus was confined to the watery tissue, while the luxuriant growth showed what an enormous quantity of mycelium the tissue contained. In a few days it had spread all over the hitherto sound parts.

From a comparison of the mycelia, it is evident that the restricted black spots scattered over the sound fruit are the result of ineffectual attacks of the fungus on the fruit, most probably when it was on the tree. In these cases the fungus could not penetrate the rind, but after the fruit had been gathered it easily entered through the stalk. The two effects are caused by the same fungus, but the rot does not, or did not in this case, extend inwards from the superficial black spots.

As is usual in such cases, the extremely abundant mycelium did not develop any fructification. This was obtained from the second specimen, which was placed, uncut, under a bell glass. In a few days it turned pale yellow round the stalk, as in the first example, and then developed large, dull black, or blackish brown patches at that end of the fruit. These spots are caused by the fungus attacking the rind from the interior; those previously referred to were the results of its attack from the exterior. Subsequently, the epidermis on these patches ruptured and disclosed dull brown masses of spores, from one-hundredth to one-fiftieth of an inch in diameter, surrounded by the upturned epidermis; and as the number of these masses increased, the whole of the black spots became covered with confluent spore masses. These masses are pinkish when dry. The individual spores are hyaline and cylindric, and measure 12 to 19 microns in length and 4 to 5 microns in breadth. The rotten fruits were kept for several weeks, but no other fructification was discovered, although that already described is only one stage in the life history of the fungus.

The fungus is a *Glœosporium*, evidently *Glœosporium mangae*, Noack, which was first found on mango fruits in Brazil. Two other species of *Glœosporium* have been found on mango

leaves; one of them, *Glœosporium mangiferae*, P. Henn., was found on the young leaves of a mango tree in the Berlin Botanical Garden, while the other, which rejoices in the name *Glœosporium Raciborskii*, P. Henn., was found on young mango leaves in Java. These differ in the colour of their spore masses, and slightly in the size of their spores; but since it is known that *Glœosporium* spores are variable, and that the colour of the spore mass in species of this kind may vary according to the substance on which they are grown, it is highly probable that the fungus is the same in all cases, in spite of the three names. Investigation of the mango leaves has not yet been undertaken in the present instance; the spots caused on them by these fungi are brown or blackish brown, becoming grey, and dry, after the fashion of "Grey Blight" spots.

If the fungus lives on the leaves, it would be necessary to spray the tree in order to get rid of it. But the specimens appear to show that it cannot make much impression on the growing fruits, although it easily effects an entrance through the stalk after they have been gathered. In that case it would probably be sufficient to treat the fruits, after gathering, with a weak fungicide. Recent experiments in England and the West Indies have proved that the decay of ripe fruits can be prevented for some time by dipping them in a solution of Formalin. A three per cent. solution of commercial Formalin is used, *i.e.*, three parts of Formalin in one hundred parts of water, and the fruits are immersed in this for ten minutes. In the case of soft fruits, such as strawberries, the whole of which is eaten, they are afterwards rinsed in water, but this is unnecessary with fruits which possess an inedible rind. They are then placed on wire netting, or a wooden frame, to drain and dry. This method should be followed in the case of mangoes, when the crop is attacked by this disease.

It is not clear why mangoes should be closely packed to ripen, instead of being merely placed on shelves, as is done with apples. Where the disease occurs regularly, it would be as well to bake the packing material before using it. Of course, rotten fruits should be disposed of in such a way that they do not afford a crop of spores for further infection; probably the easiest way would be to bury them.

APICULTURE.

PRACTICAL INSTRUCTIONS FOR BEGINNERS.

The Conditions under which Bees Build Straight Worker Combs from Starters.

By E. D. Townsend.

(From the *Gleanings in Bee Culture*, Vol. XXXVII., August 1, 1909, No. 15.)

Although we use and recommend full sheets of foundation in wired frames, it may be well to consider how and when one can get along with starters only in brood-frames, as some may not want to use full sheets.

Bees build two sizes of cells in their comb-building. The larger size run about four to the inch, and are used for rearing drones and sometimes for storing honey. The smaller cells run about five to the inch, and are used for rearing workers and for storage. The bee-keeper should strive to get all-worker combs built; for, in spite of all the care that can be taken, more than enough drone comb usually appears. Of course, in case of an extra-fine colony that one desires to breed from, a solid drone comb can be given in order that there may be plenty of drones of this desirable stock in the yard.

It is a fact that bees under certain conditions build almost all worker comb; and it is also true that, under other conditions, a great deal of undesirable drone comb is built. For instance, a new medium-sized swarm, placed in a hive of a size that may be filled with combs and brood in about 23 days or less, ought to build worker comb mainly, although some of the last combs built may contain a few drone cells. The secret seems to be in having just the right number of workers and just the right amount of honey coming in, so that the bees will draw out the combs no faster than the queen can occupy them with brood. As long as this condition lasts we should expect the bees to build worker combs. From this we see that, in order to get good results in comb-building from a natural swarm, this swarm should be of just the right size, and there should be

honey flow of, say, three or four pounds a day.

We will suppose a large swarm is hived during a period when honey is coming in freely. At this time there is too much honey coming in for the best results in comb-building in the brood-nest if the whole force of workers is compelled to do all their work in the brood-nest. The remedy is to put most of the workers at work in the supers. Most beginners fail in doing this; but the principle is to make surplus receptacles more inviting to the workers than the brood-nest, and the bees will immediately go up into the supers on being hived. Our comb-honey super with extracting combs at the sides makes ideal arrangement for this very thing.

It is plain to see that, if most of the honey being carried in is placed in the sections, where it should be, the queen will not be hurried to keep pace with the workers, consequently nearly all-workers comb will be built. The brood-nest should be filled with comb during the first 23 days after the swarm is hived, for the queen must keep up with the workers and lay in nearly every cell as fast as it is drawn out, or the bees will begin to store honey in the cells. When this condition arrives, the bees, on the supposition that the queen has reached her limit, and that the rest of the combs will be used for storing honey, begin to build the storage size or the drone-cells in the brood-nest. This is likely to occur in about 25 days after the swarm is hived; for by this time the brood is beginning to hatch out in that part of the hive where the laying began. From this time on the queen has nearly all she can do to keep the cells filled with eggs where the young bees are hatching. This means that the comb-building part of the hive is neglected, and that the bees build store or drone comb to a great extent until the hive is filled.

It sometimes happens that a very late swarm will issue; and since the season is nearing its close, it is not possible for such a swarn to build more than five combs before the honey ceases coming in. We hive swarms as usual, and in about two days five of the frames having the least combs built are removed and a division-board placed up against the remaining five frames, these five having been shoved over to one side of the hive. If a super is given such a swarm at the time of hiving, it must be a nearly finished one, as the bees will need most of their time to finish up the five combs in the brood-nest. If one has two of such five-comb colonies they can be united at the close of the season, so that there will be none but full-sized colonies to winter. A better plan than this for late swarms, or for any small after-swarms that one may have, is to hive them on full sets of combs taken, possibly, from hives in which colonies died the previous winter. This is a very good way to get such combs filled with bees, but some swarms hived in this way may need feeding for winter.

There are artificial ways of handling bees so that they will build good worker combs. I refer to the plan of shaking the bees into an empty hive, in the same way that a swarm is hived. If a colony is divided into nuclei of, say, two or three combs each, and each nucleus given a young queen reared the same year, such little colonies will build very nice worker combs; but the beginner will not be interested in this artificial way of making increase, for he should stick to the natural-swarming plan for his increase until such time as he has had experience and made a success of getting a crop of honey. In fact, there are many things to be learned before a begginer should take up artificial ways of making increase.

It is just a question in my mind whether there is a better or more profitable way of making increase in the production of comb honey than the natural-swarming method. In extracted-honey production, when the bees will not swarm enough to make up the winter loss, then artificial swarming must be resorted to.

Some Conditions where Bees build mostly Drone Comb.

Any colony found rearing drone brood-nest will, if comb is removed and an empty frame put in its place, build drone comb. It can be depended upon, moreover, that a colony of bees wintered over, containing a queen reared the season before, or one older, will build drone comb until the time that it swarms. By this it can be seen that it is necessary to replace any combs removed from a colony before it swarms in the spring or early summer, with an empty comb or with a frame containing a full sheet of foundation, or else drone comb will be the result. To be sure that a colony will build a large percentage of worker comb it is necessary to remove all the brood and to cause the bees of that colony to begin all over again, as in the case of natural swarming; or, as mentioned before, the colony can be broken up into nuclei, each nucleus containing a young queen.

Remus, Mich.

SCIENTIFIC AGRICULTURE.

THE GROWTH OF LEGUMINOUS CROPS AND SOIL INOCULATION.

By W. Biffen, B.Sc.

(From the *West Indian Bulletin*, Vol. X., No. 1, 1909.)

The fact that the growth of leguminous crops, as peas, beans, clover, etc., instead of diminishing the fertility of the land, often result in an increase of its crop-yielding capacity, was known and acted upon by practical workers in agriculture from early times, although it is only within comparatively recent years that any reason was brought forward which accounts satisfactorily for the matter.

In the eighteenth, and greater part of the nineteenth centuries, while leguminous crops were frequently included in farm rotations in European countries, opinions differed as to the actual way in which these plants were able to make such good growth—often without the aid of any nitrogenous manure—and at the same time to leave the land in such a condition that highly satisfactory returns were obtained from a succeeding cereal crop. By many it was thought that this was explained by the deep-rooting habit of the legumes, which enabled them to tap resources of moisture and food in lower strata of the soil, untouched by other plants. Liebig, a welll-known agricultural chemist, brought forward the theory that clover and other broad-leaved plants were able to obtain considerable supplies of nitrogen from the air, this nitrogen being absorbed not in the elementary state, but in the form of ammonia and other compounds, which exist in small quantity in the atmosphere.

The means by which plants obtain the nitrogen necessary for their growth, and the proportion between the quantity of nitrogen supplied in the manure and that removed in the resulting crop, were investigated by Boussingault, a French experimenter, about the middle of the nineteenth century. Boussingault weighed and analysed the crops produced on his own farm during six separate courses of rotation (all of which included a legume crop). As a result, he found that, on the whole, from one-third to one-half more nitrogen was removed in the produce than was supplied in the manure. He further observed that the excess of nitrogen in the crop over that provided in the fertilizer was especially great in the case of a leguminous crop. This naturally pointed to the conclusion that the known value of clover, peas, and other plants of this family was due to a power possessed by them of enriching the soil with nitrogen obtained from some outside source, most probably the air.

Further experiments carried out by Boussingault, however, and also experimental work conducted by Lawes and Gilbert at Rothamsted in England, not only with legumes, but with plants ot other families as well, failed to substantiate the growing belief that the free nitrogen of the atmosphere was available as food for growing plants of any family. As a result, the matter rested for a time, until new investigations carried on in Europe and America, reopened the question, and about the year 1883 evidence was brought forward which was sufficient to prove that plants of the legume family, under certain conditions, are capable of utilizing the free nitrogen of the air as a source of food supply.

Among the many investigators of this question were two Germans, Messrs. Hellriegel and Wilfarth, to whom belong the credit of clearing up the whole matter of nitrogen assimilation by leguminous plants. In experiments conducted by these two scientists, the medium of cultivation employed consisted of sterile sand, in which were planted the seeds of plants belonging to different botanical families. The necessary plant food was supplied in the form of nutrient solutions. Mineral plant food was given in all cases, but it was observed that when combined nitrogen was withheld, all the seedlings of plants belonging to orders other than the Leguminosæ died from starvation as soon as the nitrogen contained in the seed was used up. By far the greater number of the legumes (peas) grown, died at the same stage, but it was noted that one or two pea seedlings recovered and made good growth, despite the absence of combined nitrogen. In such cases, examination always showed that the roots of the plant were set with little nodules, which, it was known, are generally characteristic of the growth of legumes under normal conditions in the field. No nodules could be found on the roots of the plants which died. A further series of experiments was then started, in which pea plants, grown in sterile sand, were all fed with solutions of mineral plant food, but to some were

added, in addition, just at the stage when the seedlings were dying of nitrogen hunger, small quantities of a watery extract of ordinary fertile soil. As a result, the young plants so treated recovered and grew to maturity, their roots in every case developing nodules similar to those already referred to.

Hellriegel and Wilfarth were, therefore, bound to conclude that the power possessed by peas and other leguminous plants of appropriating free nitrogen from the air, and utilizing it in building up their own tissues, was dependent upon the formation of nodules upon the roots of these plants. The experiments in which the addition of watery extracts of fertile soil resulted in the revival and renewed growth of the seedlings previously dying from nitrogen starvation, led further to the belief that the nodules themselves were due to inoculation of the soil—and hence of the roots of the plants—with some species of micro-organism. Other investigators, notably Lawes and Gilbert, confirmed the work of Hellriegel and Wilfarth, the results of which were published in 1886. A further step in advance was made by Beyerinck, who demonstrated that the root nodules on leguminous plants were full of bacteria, which could be cultivated also on various artificial media. Beyerinck gave the name *Pseudomonas radicicola* to the bacteria in question.

The *Pseudomonas* bacteria appear to be widely distributed in most fertile soils, although they naturally exist in much greater quantity in land on which legume crops are frequently grown. The organisms, as grown in artificial non-nitrogenous culture media, are observed to be exceedingly minute in size, rod-shaped, and generally in rapid motion. They exist free in the soil in this form, and enter the host plant through the root hairs, forming tubercles or nodules on the younger rootlets only. Within the nodules, however, the bacteria frequently undergo considerable modification, and in different plants they assume rather large rod- or Y-shaped forms. The irregular forms are especially numerous in the older tubercles. At the same time they increase enormously in number.

The investigations carried out, as described above, enabled a conclusion to be finally reached which afforded a satisfactory explanation of the observed facts, and of the contrary results which had at different times been obtained in experiments on the matter. It was evident that the bacteria in the root nodules were the agency by which leguminous plants were enabled to assimilate nitrogen from the air, and that, in the absence of these organisms, peas, clover, etc., were as dependent upon the supply of combined nitrogen in the soil as plants of other botanic families, *e.g.*, sugar-cane, cotton, etc. Since the relationship of the nitrogen-assimilating bacteria to the legume cannot be regarded as in any way parasitic, but is rather a physiological partnership of mutual advantage, the term *symbiosis* (literally 'living together') has been applied to describe it. The plant supplies the necessary carbohydrate material which the bacteria require for their life purposes, and the micro-organism in turn gathers from the air nitrogen which is ultimately utilized by the legume plant. It may here be mentioned that the mechanism of the actual process by which the plant avails itself of the nitrogen compounds elaborated by the micro-organisms is still incompletly understood. It is possible that the host plant may attack and absorb the highly nitrogenous bacteria, or, on the other hand, it may avail itself of the soluble and diffusible substances formed within the bacterial cell. The latter appears the more probable explanation, since before the plant could utilize the nitrogenous compounds forming the substance of the bacterial organisms, it would be necessary that the latter be first broken down and dissolved. They would, in fact, have to be brought into a condition in which the plant could absorb them as food, by a process analogous to that in which the insoluble food supply in seeds is dissolved for the benefit of the developing embryo on the germination of the seed. This process of solution is effected by means of various ferments or enzymes, but, so far, no proteolytic ferment (*i.e.*, one capable of dissolving proteid or nitrogen compounds) has been discovered in leguminous plants, and therefore there is little basis for assuming that these plants secure the nitrogen collected by the bacteria in their root nodules by dissolving and absorbing the latter.

The figures which have been placed on record showing the actual amounts of nitrogen added to the soil, as the result of growing various leguminous crops, are useful as giving a clear idea of the value of including such crops in farm and estate rotations. Even in the course of a single season these quantities of nitrogen may be quite large. Experiments with velvet beans in Alabama showed a gain of nitrogen amounting to 213 lb. per acre, while with the same crop, gains of 172 lb. and 141 lb. per acre were obtained in Louisiana and Florida respectively. Trials with cowpeas have

shown equally satisfactory results. A publication of the U. S. Department of Agriculture mentions that in a very large number of experiments with various legume crops carried on in sixteen States, a gain of 122 lb. of nitrogen per acre was indicated. At the Delaware Experimental Station, a crop of crimson clover was found to have added as much as 200 lb. of nitrogen per acre to the soil in one season. Cowpeas are not infrequently grown in rotation with cotton in some of the cotton-growing districts of the Southern States of America. An instance reported by the Alabama Experiment Station indicates the beneficial influence of the legume crop on the succeeding crop of cotton. In this case there was noted an increase of 696 lb. in the yield of seed-cotton to the acre, or 83 per cent., as the result of ploughing under a crop of cowpea vines on land which had been in cotton in the previous season.

The annals of the Rothamsted Experiment Station contain many illustrations in point. Thus an experiment is recorded in which a piece of land, which in the previous five years had grown cereal crops without nitrogenous manure, was divided into two parts in 1872, one being sown with barley and the second with clover. Barley was again grown on the first plot in 1873, but the clover was allowed to stand, three cuttings being made for fodder purposes during the season. The quantities of nitrogen in the crops from the two plots were 37·3 lb. in the barley yield, and 151·3 in the clover. An analysis of the soil was made after the crops had been removed, which showed a content of 0·1566 per cent. of nitrogen in the first 9 inches from the surface in the plot where clover had been grown for two seasons, as compared with a nitrogen content of 0·1416 per cent. on the other portion. In 1874, barley was once more grown on both plots, the quantity of nitrogen removed in the barley following barley being 39·1 lb., while in the barley following clover 69·4 lb. were removed.

Another experiment was carried out on land which at the start contained 2,657 lb. of nitrogen per acre in the first 9 inches from the surface. Barley and clover were grown in 1883, and clover only in 1884 and 1885. It was estimated that 319·5 lb. of nitrogen was removed in the crops cut during the three years, but a soil analysis made at the end showed that nitrogen equal to 2,832 lb. was present in the top 9 inches, or a gain of 175 lb. per acre in the three years, making a total, with the crop removed, of nearly 500 lb. of nitrogen per acre to be accounted for. The work, therefore, done by this partnership between leguminous plants and the nodule-producing bacteria is of the utmost importance, and must annually add to the wealth of the world many hundreds of thousands of pounds sterling.

With the facts already enumerated before them, it was natural that workers in agricultural science should begin to debate the question whether the majority of cultivated soils were sufficiently well stocked with nitrogen-gathering bacteria to give the best results when a leguminous crop was grown, or whether, by the introduction into soils of the suitable organisms, and the more extended growth of legumes, considerable increase in crop yields could not be obtained. A great deal of experimental work in relation to this subject has been done in the past twenty-three years.

In work of the nature referred to, it is obvious that the main point is to ensure the presence of the assimilating bacteria in the soil under experiment. This can be done by distributing over the land, and slightly harrowing in, a supply of soil taken from a field which has just previously yielded a flourishing crop of the legume to be grown. As early as 1887 soil inoculation experiments of this kind were undertaken by Salfeld at the Moor Culture Experiment Station, Bremen, Germany. The trials were made with such legumes as lupins, serradella, clover and beans, on reclaimed peaty and sandy soils, on which, without inoculation, such crops made but little growth, and developed no root nodules. About 3½ cwt. of suitable soil were distributed per acre over the land, and harrowed in before sowing the seed. The results of Salfeld's work were strikingly successful. As the season advanced, the effect of the inoculation was markedly evident in the dark-green colour and luxuriant growth of the plants, on the land which had been treated as described, as compared with the land where no soil had been scattered, which bore very small yellow plants that ultimately died of nitrogen hunger.

Salfeld's results were received with great interest, and the example thus set was shortly followed by a number of investigators working with many different kinds of soils. A satisfactory measure of success was achieved in some instances, but many cases were recorded in which the results were negative, and the opinions entertained as to the practical value of soil Inoculation were of a very contradictory nature. On sandy heath soils, on moorland recently placed under cultivation, and on raw soils brought up from deeper layers by the plough, the operations had undoubt-

edly been proved to be highly beneficial, but on the majority of cultivated soils it was not evident that inoculation had been attended with any benefit.

With the extension of experiments similar to those of Salfeld, one or two disadvantages connected with this method of soil inoculation began to make themselves felt. The transport of large quantities of soil from one district to another was naturally expensive. Injurious fungi, together with weed seeds, might be introduced into the soil, with the desirable bacteria. These considerations, combined with the fact that the nitrogen-assimilating organisms could be isolated from the root nodules of legumes, and cultivated on various artificial media, led to greater attention being paid to the possibilities of inoculation with pure cultures of the *Pseudomonas* bacteria, and in the past twelve years or so, a number of preparations, all containing this organism, have been brought forward for soil inoculation purposes.

In this connexion there arises a question which is obviously of considerable importance in influencing the success of any effort at soil inoculation, but which has not yet been definitely settled. This question relates to the identity of the various bacteria which are found living in association with different species of Leguminosæ. Much investigation has been done with the object of ascertaining whether all the organisms living in symbiosis with various agricultural leguminous crops are identical with *Pseudomonas radicicola*, first isolated by Beyerinck from pea plants, whether the different kinds are varieties of this species, or whether there are different species associated with particular plants. Colonies of bacteria cultivated from root nodules from different species of legume show many points of similarity, but also some points of difference. In early experiments carried out by Hellriegel, it was seen that a watery extract of soil on which clover and beans had been grown was instrumental in inducing nodule formation on clover and bean seedlings grown in sterile sand, but had no effect whatever on serradella and lupin plants growing under the same conditions. When an extract from a sandy soil which had just previously borne the latter plants was added, however, the serradella and lupins formed nodules on their roots and grew apace. Hellriegel therefore concluded that there were essential differences between the bacteria from the various legumes. The evidence that has since been brought forward seems to point to the view that all the bacteria inhabiting the root tubercles of leguminous plants, which are the agency of nitrogen assimilation from the air, belong to the species *Pseudomonas radicicola*, but that if this organism is grown for some time continuously in association with one kind of plant only, it becomes so modified as to be specially adapted to give the best results with this species alone, and loses its efficiency in greater or less degree for all other kinds of legumes. Experiments conducted by Nobbe and Hiltner prove that the best results from inoculation can only be expected when the crop grown is inoculated with bacteria from the same species of plant.

As already mentioned, pure cultures of the root nodule bacteria had been prepared on various artificial media, and in 1896, two Germans, Messrs. Nobbe and Hiltner, developed this idea on a commercial scale. Cultures of the organisms, grown on a gelatine medium, were started by infection from root tubercles from the different leguminous plants cultivated as field crops, and this preparation was placed on the market contained in small glass bottles, under the name 'Nitragin.' In using the nitragin for inoculation purposes, the nutrient jelly was to be dissolved in a quantity of lukewarm water, and the solution sprinkled over the seed, thorough distribution of the bacteria being ensured by this means. The seed was then to be dried before planting.

The merits of nitragin were thoroughly tested at experiment stations and on private farms both in Europe and America. It was hoped that the preparation would supply not only nitrogen-gathering bacteria to soils lacking these organisms, but bacteria of a high degree of efficiency. Although in the first two seasons a few favourable reports on the results obtained from the use of nitragin were received, by far the greater majority of the returns sent in were of a negative character, and briefly, it may be stated that the preparation turned out to be a distinct failure. It seemed after all that the pure culture method of inoculation, from which so much had been expected, was less reliable than the older plan of introducing the nitrogen-gathering organisms by distributing a supply of fertile earth from fields that had lately borne flourishing legume crops.

Despite the unsatisfactory results which followed the first attempt to establish the use of pure cultures of *Pseudomonas radicicola* as the standard means of inoculation, the matter still continued to receive a good deal

of attention. On further investigation it was concluded that the chief reason which accounted for the failure was the unsatisfactory nature of the medium (gelatine) upon which the bacteria had been grown. Gelatine differs essentially from the media in which the bacteria normally live, *i.e.*, the soil and plant cell, principally in that it is of animal oirgin, and contains large quantities of nitrogen. With the provision of abundant nitrogen at hand, the bacteria are discouraged from utilizing the free supply of the air, deteriorate rapidly, and either die out altogether, or lose, wholly or in part, their power of fixing atmospheric nitrogen.

There was another point which had been overlooked in designing the method of inoculation described, but which later investigation indicated had helped to prevent the full success of the inoculation efforts. During the preliminary process of germination, seeds excrete certain soluble substances which have a detrimental effect upon the vitality of the assimilating bacteria, and, as a consequence, the organisms are unable properly to infect the legumes, unless some special steps are taken to neutralize the poisonous effects of the excretions mentioned. It was found subsequently, that the latter could be made harmless to the seed by adding to the water in which the cultures were prepared, a small quantity of certain soluble salts, or of skimmed milk.

These points being recognized, other culture media, notably agar jelly (which is prepared from a kind of sea-weed, and contains practically no nitrogen) were tried, and these efforts were attended with a greater measure of success. In Bavaria, for instance, during the year 1903, ninety-eight inoculation experiments were carried out with Hiltner's agar nitragin. Of these, eighty-one were favourable, nine negative, and eight doubtful—a remarkably good result, since in some cases, increased yields followed inoculation even on soils that had already borne good crops of the corresponding legume. Nobbe and Hiltner also employed various liquid preparations as culture media in which to grow the bacteria, and these were found to be better adapted to maintain the vitality of the organisms for a longer time than agar jelly and other solid media.

Hellriegel and Wilfarth's discoveries, and the results of Lawe and Gilbert's work at Rothamsted excited considerable attention in the United States, and extended investigations on the results of inoculation with different species of legume plants were started in that country. At first, the method employed was that of inoculation by means of earth from other legume fields. The two crops which appeared to benefit most by this practice were the soy bean and alfalfa. In the case of clover, cowpeas, field peas, beans, and vetches, the organisms responsible for nodule formation and assimilation of nitrogen appeared to be already present in most cultivated soils, and these crops gave good returns, and did not appearently require inoculation.

At a later stage the United States Department of Agriculture turned its attention to the subject of artificial cultures of *Pseudomonas radicicola* for inoculation purposes. Dr. G. T. Moore, of the Bureau of Plant Industry, undertook the work, and devised the method of preparing the cultures. Moore's method differed somewhat from that of Nobbe and Hiltner. The American scientist first prepared an active culture of the nodule-bacteria in a liquid medium, the composition of which included little or no nitrogen, in order that the assimilating power of the organisms might be increased. Absorbent cotton was then dipped in the liquid culture, and subsequently dried rapidly at a low temperature. In this condition they retained a number of the bacteria, and formed a convenient medium for transmitting the organisms, and for starting new liquid cultures. With the cotton was sent out, in every case, a packet containing suitable quantities of cane sugar, potassium phosphate, ammonium phosphate, and magnesium sulphate, which were to be dissolved in a large bulk of water, thus forming a nutrient solution in which the bacteria multiplied rapidly under favourable conditions when the cotton culture was added. The seed to be inoculated was placed in this solution for a time, being afterwards dried before sowing.

Moore's cultures were very extensively tried by the United States Department of Agriculture, in co-operation with working farmers all over the country during the year 1904. To everyone who made application, a free packet of inoculating material was supplied, with detailed instructions as to the method of using it. In this way about 12,500 tests were made under the most varied conditions.

With the arrival of reports on the results of all these trials, it soon appeared, however, that the general measure of success which had followed inoculation with Moore's cultures was far below what had been anticipated. It exhibits,

indeed, little superiority in its influence upon the crop yield to that shown by the original nitragin preparation of Nobbe and Hiltner. Although in a very considerable number of cases, small increases of crop followed inoculation, yet the general verdict from the American experiment stations, and also from European stations where Moore's cultures had been tried, was that these preparations were inefficient. The advantages of inoculation by means of pure cultures were obvious in theory, but the ideal pure culture, the use of which would cause these advantages to appear in practice, had yet to be devised.

Investigation carried out with the object of ascertaining the cause of these disappointing results showed that the method of preserving the bacteria in a dried form on cotton was not so satisfactory as had been supposed. Many of the organisms perish during the process of drying, and any considerable change in temperature and moisture conditions that may take place previous to the use of the culture has a detrimental effect upon the vitality of the bacteria that still remain. By Moore's method, too, the actual preparation of the culture solutions with which the legume seed was to be treated before sowing, had to be carried out by the farmers themselves, who would hardly be likely to work under the careful and exact conditions that would be followed in the laboratory. Under ordinary farm circumstances, the risk of contamination by the introduction of foreign bacteria, moulds, and yeasts, from the air, from water, or by means of the utensils employed, was at its maximum, and many of the introduced organisms might be instrumental in preventing the growth and multiplication of the nitrogen-gathering bacteria of the cotton culture.

Culture preparations for inoculation of leguminous crops are still sent out by the United States Department of Agriculture, but as a result of the difficulties that have been experienced, the use of absorbent cotton has been abandoned, and the medium employed, consists of nitrogen-free liquid put up in hermetically sealed bottles. Numbers of different cultures are prepared, which correspond to the different legume crops cultivated, each culture being adapted to give the best results with a particular species. Thus cowpea cultures, alfalfa cultures, clover cultures, etc., are all obtainable. The directions that accompany each bottle warn the recipient to utilize the material within ten days or two weeks, as otherwise deterioration may set in, which will render the culture useless.

Nearly two years ago Professor Bottomley, F.R.S., of London, turned his attention to the subject of soil inoculation, and as the outcome of his investigations, he brought forward another pure culture preparation, somewhat similar to that of Moore, to which the name 'Nitro-bacterine' was given. 'Nitro-bacterine' was described by the originator as a 'powder preparation of the bacteria.' It was sent out in sealed packets containing cotton wool, as in the early American method, but the medium also contained in addition a number of dry, earth-like particles. With these packets were sent also small quantities of soluble nutritive substances, to be dissolved in water, and the culture solution was prepared and utilized in a manner similar to that already described in the case of Moore's cotton cultures. The importance of using pure water that had been boiled and allowed to cool, perfectly clean utensils, and of taking every precaution to protect the solution from contamination was emphasized by Professor Bottomley. Those testing nitro-bacterine were advised that inoculation might also be effected by 'watering' the young legume plants with the culture solution. It may be added that Professor Bottomley did not confine his attention to leguminous plants alone in this connexion. He also brought forward other culture preparations which he hoped might be instrumental in enabling cultivated plants belonging to certain other natural orders to draw upon the stores of atmospheric nitrogen for food purposes.

The results so far reported with nitro-bacterine have not been of such a nature as to indicate that this preparation is in any way superior as an inoculating material to Nobbe and Hiltner's nitragin or Moore's cotton cultures. In the summer of 1908, some experiments with Professor Bottomley's culture material were conducted with garden peas at the Wisley Gardens of the Royal Horticultural Society. These are reported upon in detail in the *Journal* of the Society for November last (Vol. XXXIV., part 2), and a summary of the results was given in a late number of the *Agricultural News* (Vol. VIII., p. 62). These results were of a purely negative character, and the closing paragraph of the report is as follows: 'It is concluded that the inoculation of leguminous crops with "nitro-bacterine' in *ordinary garden soils* is not likely to prove beneficial.'

During the year 1908, the effect of inoculation on the returns given by various leguminous crops was tried at Antigua and at Grenada. In the former island where cowpeas, woolly pyrol, and

alfalfa were the crops in connexion with which the investigations were made, nitro-bacterine was the inoculating material employed. Experiments were conducted at the Experiment Station, and also on estates, the property of Messrs. Henckell, Du Buisson & Co., at the instance of the owners. At Grenada, cowpeas formed the crop under test, and a liquid culture preparation, obtained from the United States Department of Agriculture, was employed. The effect of inoculating sugar-cane plants with the material forwarded by Professor Bottomley for that purpose was also tried both at Antigua and Barbados.

At Antigua the nitro-bacterine culture solutions were prepared at the Government Laboratory, and it is remarked in the report on the results of the experiments, that satisfactory growth of the culture took place in the case of every package. Seed of the different legumes under trial was also inoculated at the Laboratory, and portions of the culture solution were afterwards distributed to the centres where the experiments were to be made, for inoculation of growing crops, and of the soil. Where crop and soil inoculation was carried out, two inoculations were made, at an interval of a fortnight.

Cowpeas were grown under experiment at Cassada Garden and at Fitches' Creek, and the effects of inoculation both by immersion of the seed in the culture solution before sowing, and of 'watering' the soil with the sclution after sowing were tried. In no instance did inoculation have any influence in increasing the crop yield, however. Indeed, the highest return at Cassada Garden was given by the plot sown with seed that had not been inoculated, and which was not watered with the culture solution.

It is to be presumed (as Mr. Tempany states in his report,) that the soil was well stocked with the bacteria responsible for nodule formation on this particular crop, or that the soil was well supplied with available nitrogen. Examination of the roots of inoculated and untreated plants showed that though, on the whole, there appeared to be slightly more nodules on the roots of the inoculated plants than on those which had received no treatment, the difference was not very marked.

Experiments with woolly pyrol were conducted at the Experiment Station, and at Fitches' Creek, Cassada Garden, and Gambles estates, the experiment plots being $\frac{1}{8}$ acre in area in every case. It is interesting to note that, in the case of one estate at least (Cassada Garden), the results of inoculation with this crop were more definite and satisfactory. From the control plot, which received no inoculation, 330 lb. of green bush were gathered. A second plot, sown with uninoculated seed, but the soil of which later received applications of the culture fluid, yielded 700 lb. of bush; a third plot that had been sown with inoculated seed, but received no further treatment, gave a return of 970 lb. of green bush, while from the fourth plot—sown with inoculated seed and also 'watered' with the culture fluid—1,015 lb. of bush were reaped. The results for two plot experiments at Gambles estate are also reported, and in these also, although to a lesser degree, the beneficial effects of inoculation are observable. From the untreated plot, 30 lb. of green bush were reaped, while 50 lb. of green bush were obtained from the plot sown with seed that had been inoculated. It may be added that a good number of nodules were present on the roots of all the plants examined, but it is stated that no marked differences as to number could be observed on the inoculated and the uninoculated plants.

At Fitches' Creek and the Experiment Station no results were obtained, since the woolly pyrol plants were destroyed by caterpillars. A scheme of inoculation experiments with cowpeas was carried out in 1908 at Grenada at the Botanic Station and on six estates. These experiments were designed to answer two questions: (1) whether any benefit is to be derived from inoculation of leguminous crops such as cowpeas on Grenada soils, and (2) whether, by inoculation, leguminous green dressings such as cowpeas can be grown under the shade produced by mature cacao trees. With the object of deciding the first question, two plots, each $\frac{1}{2}$-acre in area, were sown with cowpeas, at the several centres, one plot being planted with inoculated, and the other with uninoculated seed. To investigate the possibility of growing leguminous crops under shade, plots of one acre in extent, covered with full-grown cacao trees, were planted with inoculated cowpea seed.

In regard to this latter question, the results obtained at all seven centres were of the same nature, and indicated that inoculation had no effect in encouraging the growth of the cowpeas when planted beneath the cacao. The amount of shade varied from fairly light to very dense, but in no case did the peas do more than produce one or two leaves, and they soon died, showing all the symptoms of lack of sufficient light.

Varying results were obtained on the cowpea plots in the open. At the Botanic Station, and on two of the

estates, the returns showed no difference whatever in favour of inoculation. At two other estates the returns from the inoculated plots were slightly superior to those which had not been treated. Finally, at the two remaining estates, Dougaldston and Diamond, the reports state that the inoculated areas gave yields considerably higher than the untreated plots. No actual figures as to the weights of produce reaped are given, but it is mentioned that on Diamond estate, the plants on the inoculated plot were about one-fourth as large again as on the uninoculated land.

Reference has been made to Professor Bottomley's culture preparation for inoculating sugar-cane plants. It may be added that a number of cane plants were inoculated at Antigua and Barbados in accordance with the directions supplied, but that in no case could inoculation be observed to have any effect whatever.

From the facts which have been enumerated, it will be seen that the history of past attempts at soil inoculation by artificial cultures, forms a record chiefly of failures, although numerous instances have been reported in which a certain measure of success has resulted. The failures which have been recorded cannot be regarded as indicating that the operation is in itself valueless, since the importance of ensuring that the nitrogen-gathering organisms are present in the soil is obvious. But it is evident that the earlier and more enthusiastic advocates of the process formed an exaggerated idea of the advantages which they believed would in general follow soil inoculation, and later researches have enabled a truer estimate to be formed of the conditions and circumstances under which the process is likely to be followed by beneficial results. It was at one time hoped and even claimed, that inoculation of any soil on which a leguminous crop was to be grown, would undoubtedly lead to a satisfactory increase in its crop-yielding capacity. Experimental results soon showed the fallacy of this belief, and indicated that the advantages of the process are not general, but may be expected only under certain limited conditions. Briefly stated, the conditions under which inoculation may be expected to prove distinctly advantageous are on virgin soils newly brought under cultivation, on reclaimed peat lands, and also on cultivated farm lands when the leguminous crop to be planted has not previously been grown in the neighbourhood, and on the soil in question. For inoculation to have its full effect, these soils must be properly drained, and contain suitable proportions of lime, phosphates, and potash. But in the majority of cases it would appear that the process is not capable of increasing to any appreciable extent the crop-yielding capacity of most cultivated farm and estate lands, more especially if ordinary leguminous crops have been regularly included in the rotations followed. This is due to the fact that the nitrogen-fixing bacteria which the culture preparations are designed to introduce, are already present in the great bulk of such soils, and inoculation can only prove of benefit if the organisms introduced are more efficient (their 'efficiency' being measured by the quantity of nitrogen fixed than those already present in the soil).

Reference has been made to the question of the possibility of increasing the amount of nitrogen-fixation by cultivating and introducing into the soil races of bacteria superior in vigour to those which already exist there. This is a phase of the subject of soil inoculation which has of late years received a good deal of attention. It has been found that the capacity of the *Pseudomonas* organisms to assimilate nitrogen is not fixed and unalterable, but that this power varies with changed conditions of growth. Under certain conditions they are liable to lose their power of fixing nitrogen, while at the same time retaining the capacity to multiply at a rapid rate. From this consideration it will be seen that the number of nodules on the roots of the legumes in association with which the bacteria live, does not always form a basis from which deductions can be made as to the amount of nitrogen fixed. The bacteria may lose their power of fixing nitrogen as the result of cultivation on unsuitable media, such as gelatine, among other causes.

A German Investigator, Suchting, found that the amount of nitrogen assimilated by legumes varied with the source of the bacteria, whether these were derived from the soil, from crushed nodules, or from cultures grown on suitable media. He reports that the efficiency of the last was greater than that of the other two, while the organisms direct from the crushed nodules were superior to those in a watery extract of the soil. Similarly his experiments confirmed the observation, that the most 'efficient' races of *Pseudomonas radicicola*, when grown upon unsuitable media, rapidly lost their power of nitrogen-fixation, without diminishing their power of multiplication. The source of the infecting organisms, and the manner in which

they have been propagated, are evidently, therefore, matters of considerable importance.

Future researches may result in the production of improved cultures of high nitrogen-fixing power, the bacteria of which are capable of maintaining themselves in the soil against the kindred organisms already present there; but, as pointed out by Mr. A. D. Hall, in the latest edition of his book 'The Soil,' it must be borne in mind that even if such improved races of the nodule-forming bacteria can be introduced to the plant, the improvement they can produce in the crop yield is likely to be something of the order of a 10-per cent. increase, a gain which is only really perceptible after careful and continued experiments, and one not to be detected by the eye of the ordinary farmer or planter. This appears to be the most that can be expected from soil inoculation, on most farm and estate lands that have been long under cultivation.

As indicated, however, there is no doubt that, under certain circumstances, inoculation forms a valuable addition to the means possessed by the agriculturist of adding to the fertility of the land, and the conditions which indicate that the process is likely to be attended with distinct advantage, have already been indicated. When land has been recently reclaimed from the heath or bog state, it usually happens that none of the *Pseudomonas* organisms are present. Liming is required in such cases, and on such lands it will be found that the effects of inoculation on the growth of a leguminous crop are of a very different order from those brought about on ordinary cultivated lands. It is quite usual to observe that the introduction of the appropriate organisms into the soil will change a stunted, sickly looking growth into a vigorous and profitable crop. The extension of the cultivation of a legume crop, such as alfalfa, cowpeas, etc. into a new district, forms another occasion when inoculation has been found to be valuable, and even necessary.

In this connection, since it is a practical instance in point, it is worth while to refer to the useful work that has been done in reclaiming and making fit for cultivation large tracts of barren, sandy land in East Prussia. The scheme for this work was devised and carried out by Dr. Schultz, of Lupitz, and the agency employed by him to reclaim the land consisted of growing lupins and ploughing in the green crop. Mineral manures, chiefly basic slag and kainit, were applied to the soil. The lupins store up nitrogen from the air, and thus there is gradually built up a store of humus which is not only a source of plant food, but is also of great importance from the physical point of view, in binding together the loose sand and making it retentive of moisture. On these waste lands, which in many cases had not carried any leguminous vegetation whatever, soil inoculation has proved a most valuable aid, and the process was indeed necessary to the success of Dr. Schultz's scheme. The increase in fertility of the land is indicated by the fact that the soil of a field growing lupins every year from 1865 was, in 1880, found to contain 0·987 per cent. of nitrogen in the surface 8 inches, as compared with 0·027 in an adjoining pasture. As the result of the continuance of the scheme mentioned for eleven more years, the proportion of nitrogen had, by 1891, increased to 0·177 per cent., despite the annual removal of the lupin crop, and the fact that the manuring had been with phosphates and potash only.

In regard to present views on methods of soil inoculation, the failure which so frequently attended the use of pure cultures in the past has caused their employment to be regarded with a certain amount of distrust, and in Europe and America the tendency among agriculturists has of late been to place more reliance on the original if somewhat cumbersome legume earth method. There is yet a good deal to be learned in regard to this matter, and the subject is under investigation in a number of laboratories. It is possible that in the future a practical and satisfactory method of inoculation by means of pure cultures may be evolved.

COOKERY.

HONEY *VERSUS* CANE SUGAR.

BY MRS. B. R. WINSLOW.

(From the *Gleanings in Bee Culture,* Vol. XXXVII., No. 14.)

A child's craving for sweets of some kind shows a real need of the system in that direction; but, unfortunately, the sweets at hand and usually given to supply this need are not wholesome, and serve no better purpose than to please the child's taste. In fact, the work of changing the cane sugar into grape sugar so that it may be assimilated is often too great a tax upon the child's stomach, and sickness results. This,

however, is not the case with honey. The bees have fully prepared it for immediate assimilation, and it is ready to be taken into the system without taxing stomach or kidneys. Doctors frequently order honey for those whose digestive organs are too weak to convert cane sugar into grape sugar properly. The wholesomeness of honey, however, is not disputed by those who know anything about the product of the hive. The principal difficulty in the way of its substitution for the sweets usually craved by children is the apparent limitation of its use. The child has inordinate longing for cakes and candy, and that is not always satisfied by bread and honey; therefore, to take the place of cane sugar, honey must be prepared in the same manner as cane sugar. It must be made into cakes and candies and other danities dear to the children. The object of this article is to supply housekeepers who desire to substitute honey for cane sugar, in the diet of their children, with a few simple recipes obtained from practical experience, for making this wholesome sweet into a variety of pleasing confections.

A few suggestions on the care of honey may be of benefit to those who are so situated that it is cheaper to buy in quantities. The worst place to store honey, or even to keep it for a short time, is in the cellar or any damp cool place. Honey, when extracted from the comb, readily absorbs moisture, becoming thin, and (in time) sour. The very best place to store honey is in the attic, up next to the roof, where it is hot, During cold weather, honey that is kept any length of time has a tendency to granulate, turning to a white, semi-soild granular condition. This is called "candied honey," and it frequently "candies," so solid that it must be dug out of the bucket with a knife. It is a simple matter, however, to restore it to its former condition. Place it in hot water, never over 160°, and let it stay until it has liquefied. It may take an hour, or it may take a whole day.

In the following recipes quantities are given in pints and pounds because the success of honey recipes depends upon the right proportion of the ingredients. All cups are not the same size, and do not hold the same quantity of material, therefore it is best to use a standard measure.

The simplest honey cake is the honey ginger-snap.

One pint of honey; ¾ lb. butter; 2 teaspoonsfuls ginger.

Boil together for a few minutes, and allow it to get nearly cool. Add enough flour to make a stiff dough, and roll out thin; cut into round cakes and bake quickly.

Another simple cake is the honey cookey. The recipe is given for a large quantity because they will keep indefinitely, and they are nice to have in the house all the time for the children to eat between meals. If they are wanted in smaller quantities the recipe can be reduced a half or even one-quarter.

One pint honey; one quart sour milk; 1 teaspoonful soda.

Mix well together and add sufficient flour to make a soft dough. Roll moderately thin and cut into round cakes. Bake in a slow oven to prevent burning.

A richer cookey is made by the addition of butter and eggs. One pint honey; ½ pound butter; 4 eggs; ½ pint buttermilk or clabbered cream; 1 quart flour; 1 teaspoonful soda.

Mix the honey and the butter and the eggs well and add the buttermilk. Sift in the flour and soda, and mix well. Mix in enough flour in addition to the quart to make a cookey dough that will roll out well without sticking; cut in round cakes and bake in a slow oven.

In the line of confections, some sugar must be used to make the honey "candy," but the home-made honey caramel has the advantage of being pure.

One pint honey; 1 lb. sugar; scant gill of cream.

Boil until it makes a soft ball when dropped into water. Stir in a teaspoonful of vanilla, and pour it into a shallow buttered pan to the depth of about half an inch. When cool enough to prevent its sticking to the kinfe, cut into inch squares. If chocolate caramels are desired, use a teaspoonful of melted chocolate instead of the vanilla, stirring it in just before pouring into the buttered pan,

To make honey popcorn balls, boil a pint of honey in an iron frying-pan until it is quite thick, and then stir in the popped corn. When cool, mold into balls.

As a substitute for tea or coffee for children there is nothing better than honey tea—a very simple tea made by adding a tablespoonful of honey to a cup of hot water. If not sweet enough to suit the taste of the child, add more honey.

MISCELLANEOUS.

LITERATURE OF ECONOMIC BOTANY AND AGRICULTURE.

BY J. C. WILLIS.

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NOTES AND QUERIES.

BY C. DRIEBERG.

COCONUT BEETLE.—The Government Entomologist reports: "The statement that the grubs of the Rhinoceros beetle attack the roots of adjacent plants requires corroboration. I am inclined to believe that the idea has arisen from the similarity of the grub of the rhinoceros beetle to the root-eating larva of the large Cockchafer (*Lepidiota pinguis*)."

A. W. J.—The output of cassava roots, on small areas, may be anything from 10 to 20 tons per acre. It would be safe to take the lower figure as an average for extensive plantations. The starch to be expected from this quantity may be reckoned as 3 to 4 tons. A good starch is worth in England from £14 to £16 per ton.

BEEKEEPER.—No, bees do not puncture fruit. The structure of the bee's mouth shews that it cannot do so, though they will suck the juice liberated by the puncture of the fruit fly. On the other hand, they aid materially in the fertilisation of the flowers of fruit trees.

CROTALARIA JUNCEA.—Mr. Chelliah, Agricultural Instructor, Northern Province, writes: "Hemp is largely cultivated in the paddy-fields at Alaveddi and other places, after the paddy crop is reaped, and it is considered a restorative crop. The pcds and leaves are collected and preserved as fodder for cattle, and the stems are sold for extracting fibre from. The cultivation is said to yield a return of about Rs. 50 per acre without much expense and trouble, while it improves the soil for the succeeding crop."

G. E. S.—The screwpine belongs to the genus Pandanus. The material used for hat-making in Manila is, I think, *P. utilis.* In Ceylon we have a number of species that ought to prove suitable for the same purpose. "Rampeh" is *P. latifolia.*

P. R.—According to the Inspector-General of the Indian Civil Veterinary Department, "fowl-cholera," which is such a trouble to poultry-keepers in the East, is due to an organism introduced into poultry by the common fowl tick. As the ticks are found during the day in the crevices about the fowl house and only attack poultry at night, it is advised that the buildings in which the birds are housed should be periodically painted over with hot coal-tar.

S. P.—The following is recommended as a suitable manure for sweet potatoes, in addition to the usual dressings of cattle dung or green manure: 90 lbs. each of sulphate of potash, high grade superphosphate of lime, and nitrate of soda, per acre.

W. D.—The Queensland Agricultural Journal states that the following dressing is useful against ticks in dogs: Soft soap 4 oz., kerosine 1 tea-cup, water 1 quart. Boil soap in water till dissolved, and when cool add kerosine and mix thoroughly in. Wash dog all over with this mixture, and give internally 3 to 10 grains of iodide of potash in two tablespoons of water.

T. B.—It is not generally known what difference, if any, there is between the pumelo and the grape fruit. It would appear, however, that it is not much more than the difference between the banana and the plantain. According to Dr. Morris, the grape fruit is a good deal smaller in size with a thin, pale yellow, smooth skin. The centre is seldom hollow and the seeds are generally well developed. The colour of the flesh is, as a rule, pale yellow but sometimes red. The shape may be either round or pear-shaped. In the ordinary pumelo the skin is of considerable thickness, and the fruit large with usually red pulp. There is no doubt that we have both varieties in the Island. In America the grape fruit is highly valued not only owing to its flavour, sweetness, and juiciness, but for its supposed medicinal qualities—being considered a specific against malaria.

AGRICULTURAL COLLEGE, COIMBATORE.

OPENING CEREMONY.

(From the *Indian Patriot,* July 15, 1909.)

The Hon'ble Mr. Castlestuart Stuart opened the Agricultural and Research Institute on Wednesday, and his printed address gives a full account of the history and objects of the undertaking. For a long time progress in agricultural teaching was not possible through want of funds. But in the year 1905, a favourable tide set in, when the Government of India made a generous grant to this Presidency for developing agricultural research and education.

THE CENTRAL FARM.

The land selected for the Agricultural College, the Research Institute and the Central Farm is situated mainly in a village, three miles to the west of the town of Coimbatore, and was acquired in February, 1906, at a cost of Rs. 80,000. The total area of the estate is 450·88 acres, of which 45·50 acres are wet land, 126 acres are good black loam, and 161 acres consist of red soil, all of which are under cultivation. The remainder of the estate is occupied by buildings, etc. The farm is at an elevation of about 1,360 ft. above sea-level and is approximately flat, there being a difference of 37 ft. between the highest and lowest points which are 1,650 yards apart. The Farm has been worked during the past two years, and several experiments with regard to the improved methods of tilling, the transplanting of seedlings, the effect of green manure and the cultivation of varieties of cholum, cotton, ragi, sugarcane and groundnut were carried out under the supervision of Mr. C. J. Shepperson, the Principal of the College and the Superintendent of the Farm. In the matter of crops growing attention is rightly paid to methods of cultivation rather than to obtaining results with a liberal application of manure; and with the exception of nitrate of soda, no artificial or rather, concentiated manures have been used, it being considered that a more useful impression would be made upon the minds of the ryots if good results were obtained with ordinary means than if those results were obtained with substances so costly as to be practically beyond their means.

THE COLLEGE AND THE INSTITUTE.

The foundation-stone of the handsome pile of buildings which constitute the Agricultural College and the Research Institute was laid by His Excellency Sir Arthur Lawley on the 24th September, 1906; and in the course of a couple of years the Public Works Department have completed the construction of the whole block of buildings, comprising the College and the Research Institute proper, the hostel, quarters for native officers, quarters for menial servants, residences for the officers of the Institute, &c. The main building was designed by Mr. G. S. T. Harris, then Consulting Architect to Government, and is constructed in the form of the letter H. The building which is constructed of table-moulded brick in mortar with moulded cut stone work, is Hindu Saracenic style, and has a handsome clock tower in the centre of the front block, 70 feet in height, under which is the main entrance. To the right of the main entrance are several spacious rooms, including the principal's room, with his office, and the Botanical and Entomological preparation rooms, while to the left are the Physical Laboratory, the Physical Assistant's rooms, the Chemical preparation room and the Mycological room. After passing through the main entrance, the open passage under the big library is reached, whence take off the two stair cases to the upper floor, where the Government Botanist occupies the central room over the hall, or main entrance, and has his assistants and clerks located in adjoining rooms. Continuous to this is the Entomologist's room with another for his clerks. To the left of the Botanist's room is the Herbarium, next to which are the Mycologist and his clerks and assistants occupying large and well-ventilated rooms. The Library forms the connecting link between the front and rear blocks. On passing through the main entrance to the rear block the students' main entrance is reached, to the right of which are situated the nitrogen and potash rooms, a Lecture room, a Balance room, a room for the Chemical assistants, and the Students' Laboratory. To the left of the students' entrance are situated the Stores room and other rooms, while at the eastern end of the building there is the Research Laboratory. On the upper floor immediately over the entrance there is the Students' reading room which is divided by a movable partition from a Lecture room, so that the two can be thrown into 'one, making a wide large hall which will be 76 ft. by 25 ft. Adjoining this is the Museum Preparation Room with the Museum beyond. On the western side or left of the Students' Reading Room there is a lecture room with a partition, next to which are the rooms for Entomological

and Botanical assistants, and at the eastern extremity of the building lies the Biological Laboratory. So far as the actual construction is concerned, the building operations were carried out by Mr. H. T. Keeling, Executive Engineer, under the supervision of Mr. H. H. O'Connell, Superintendent Engineer.

The College was opened to the public in June last year, when twenty students joined it. Another twenty joined the College in June last; while twenty more will be admitted in June next year. There is accommodation for sixty students in all; and the course being one of three years we may expect that from June, 1911, twenty students will be turned out every year from the College ready to take part in and further the development of Agriculture.

THE COST TO GOVERNMENT.

The total cost of the entire block of buildings approaches 8 lakhs, the main buildings in which the College and Institute are located, costing about 4½ lakhs. Besides this capital cost of 8 lakhs, the Government incurs an annual recurring charge of over Rs. 50,000 on the maintenance of the necessary staff of experts and their assistants. The superior staff consists of an expert agriculturist who is also principal of the College and Superintendent of the Central Farm, the Government Botanist, the Agricultural Chemist and Entomologist and Mycologist. Each expert is provided with assistants and demonstrators in his own branch, so that the time of the specialists may not be frittered away merely on the elementary tuition.

THE AIM OF THE INSTITUTION.

The object of the College is to send out in the course of years an army of trained agriculturists who will go amidst cultivating ryots and teach them by practical work the advantages of scientific agriculture. The department has wisely resolved that the College should be thrown open to Matriculates and even to unpassed men, so that those whose ambition in the direction of higher education is blocked may seek this avenue and thus try to perform a useful task. The educational qualifications thus required of candidates being extremely low and no fees being demanded from them there ought to be no practical difficulty in getting the requisite number of young men to apply yearly for training in the College. Though no actual promise of employment is held out to them by Government, it is possible that for some years to come at any rate every one of the students successfully turned out of the College will find employment under Government in the various agricultural stations which will doubtless be established all over the Presidency. There are already seven or eight agricultural farms in existence, and if more agricultural stations have not been established, it is due more to the lack of trained young men competent to carry on agricultural work than to anything else. In the course of a few years one may therefore expect to see every district provided with at least one agricultural farm if not more where the ryots will be able to see for themselves what advances can be made on their present methods of agriculture. On the ordinary ryot any amount of lectures on scientific agriculture makes no impression whatever, but if he could be satisfied by practical demonstrations as to the results of scientific agriculture, as he will doubtless be at these agricultural stations, he will lose no time in assimilating improvements into his time-honoured methods of cultivation. The agricultural diplomates of the college will also find employment as itinerant agricultural inspectors whose services are very much in requisition by several agricultural associations, and may also be availed of by groups of villages. There is altogether a very bright prospect in the agricultural output of the Presidency, and it is to be hoped that everything will be done by the officers of the department to second and loyally carry out the efforts and intention of Government. While no fault can be found with the rules laid down for the conduct of the College, one cannot help regretting that no serious efforts are being made to induce brilliant graduates of our University who have passed in Chemistry and Biology to undergo a training at the agricultural college, so that in time to come they may take their place as agricultural leaders of the Province and also as officers of the Agricultural Department. Though the prospects held out by the department to brilliant young men are not very encouraging, yet it must be admitted they are not altogether gloomy. There are a number of minor appointments in the Department with salaries ranging from Rs. 25 to Rs. 150, and it is expected that in the near future a few higher appointments with salaries ranging from Rs. 150 to Rs. 400 will be created which, at any rate, will prove to be incentive to young men of superior culture to take to agriculture as a profession.

His Excellency Sir Arthur Lawley arrived here this morning at a quater past 10 by motor car from Ootacamund for formally opening the Agricultural College and the Research Institute. After

the introductions were over, Mr. Stuart presented the following address on behalf of the Agricultural Department :—

YOUR EXCELLENCIES,—It is with equal pride and pleasure that I come forward to thank you for affording me and all whom, for the time being, I am privileged to represent, this opportunity of welcoming you both to an Institution which, under the friendly auspices of the Government of Madras, is certainly destined to play an important part in the education of the people. I beg to assure Your Excellencies that we are deeply sensible of your kindness so graciously manifested by your presence here to-day.

In the annals of the Department of Agriculture of Madras two dates will ever be gratefully remembered and honourably associated, Sir, with your distinguished name by all who are interested in the improvement and development of the great Agricultural Industry of this Presidency.

On the 21st September, 1906, Your Excellency not only laid the foundation stone of this Agricultural College and Research Institute, and gave your name to the new road which passes through the Central Farm, but in the memorable speech which Your Excellency delivered on that occasion, further showed much generous sympathy with the special efforts of the Department to promote the welfare and industrial prospective of our rapidly increasing population.

The 14th July, 1909, will be rendered no less remarkable by the ceremony of opening this College and Institute which Your Excellency so readily consented to perform to-day, thereby making for all time the starting point of a new epoch in the history of Madras Agriculture.

Designed by Mr. G. S. T. Harris, Consulting Architect to Government, and built in circumstances of considerable difficulty—due to the prevalence of cholera and plague—by Mr. D. M. Saiyid Abdul Rezak Sahib, the Contractor, under the able supervision of Mr. H. O'Connell, Superintending Engineer, under the immediate direction of Mr. H. T. Keeling, Executive Engineer, this noble building together with its appurtenant land, hostels, farm buildings and residences for the staff will have cost more than eight lakhs of rupees before its completion—a veritable monument to the munificence of both the Imperial and Provincial Governments and to the professional skill and indefatigable industry of all concerned in its construction. There is in the College and Institute abundant accommodation for research work in Chemistry and Botany, and room has also been provided for the Mycologist and Entomologist who form part of the expert staff contemplated in the original scheme, but whose appointments have not yet been sanctioned. The class-rooms, laboratory and hostels have been built to hold sixty students, of whom twenty will be annually admitted. The fine farm of 457 acres of land, all in a high state of cultivation, which surrounds the building, has been provided to ensure a sound and thorough training for the students in practical agriculture, and for experimental cultivation in connection with research. The college has been working in temporary buildings for the past year, as our need of trained men was so urgent that we could not wait till the College itself was ready for their reception.

The present dignified position of agricultural science in this presidency, compared with what was thought sufficient when the first steps were taken in the direction of improvement, affords justification for future encouragemet.

It was just forty-four years ago that a committee of private individuals selected by Government was placed in charge of the Saidapet Farm. We are told in their first report that they found the land "covered with prickly-pear and jungle." The qualifications of Mr. Shepperson's predecessor in office were equally unpromising. The Superintendent of the farm is described as "doubtless a good gardener, though he has but a very superficial knowledge of farming," while the "Overseer, who is a pensioned gunner," is described as "a remarkably steady, trustworthy man, but he has no knowledge of farming nor can he read or write."

Of the soil of the farm itself Mr. Robertson reported "the proportion of sand is great. Grain will seldom produce grain when cultivated on these soils." Born under those adverse conditions it is hardly a matter for surprise that the young plant of Madras Agriculture had a hard struggle for existence.

In fairness, however, to the Government of that day it must be remembered that even in Europe agricultural science was then in its infancy. English farmers were still on the full tide of prosperity, and English experts were apt to condemn root and branch every method of cultivation which differed from their own. Again and again the Madras Government had shown its full appreciation of the importance of improving the agriculture of this Presidency, but it seemed impossible to secure good techni-

cal advice. Even at the present day such men are scarce—in 1865 they were non-existent.

So far back as 1873 the Board of Revenue made the prophetic remark that "the most difficult and important object of study will be the way to influence the ryot." To this day this remains the central problem, to solve which these splendid buildings have been erected and our expert staff recruited. I can best give Your Excellencies some idea of what we hope to do at Coimbatore by briefly describing the preparations we have made to solve this question.

The first requisite for influencing the ryot is to ascertain by experiment and research in what respects his methods are faulty, and in what manner they can be improved upon. As Your Excellency so truly said at the laying of the foundation-stone of this building, "the first thing which we have to do is by experiment and research here to realise what are the proper lines upon which agriculture be run."

The ryot is after all a professional farmer of long standing. His methods have been evolved by hundreds of generations taught in the hard school of experience. Were the world in which we live an unchanging one, the ryots' present agricultural practice might perhaps suffice for his own simple needs, but change and development is the law of human existence. Population increases; prices rise and the struggle for life becomes ever more intense. Hence the necessity for securing a larger return from the land. Against the ryots' long and often painful experience we have to pit the resources of physical science. But the elementary problems of plant nutrition in the tropics and the formation of plant food in Indian soil are still awaiting investigation. Light must be thrown on these and similar problems before our advance to the ryot can be based on the sure foundation of knowledge. The experts of this Institute, however, have been generously equipped by Your Excellency's Government for the struggle, as Your Excellency's inspection of the laboratories will shortly show, and there need, I think, be little fear for the result. The secret of all progress is untiring and unceasing effort, and to use the words employed by the Madras Government in 1854, "if the effort be general, generous and long continued, it will ensure success."

Although of necessity, time will be required for reaping the fruits of research, we are to point with satisfaction to some substantial work already accomplished. The new sugar canes introduced into the Godavari Delta by Dr. Barber to combat the fungus disease which was threatening to destroy the sugar industry have been a triumphant success. The new canes have been universally adopted by the ryots, and it is now a difficult matter to find any of the canes which were formerly grown. Introduced into South Arcot, the same canes have in two years gained a firm hold of the district, while their superior qualities have revived the hopes that sugar refining from country grown canes will be added to the list of successful Swadeshi industries.

Work on the Government farms has shown that much can be and has been done already to improve the cultivation of paddy and cotton, the most important food and industrial crops respectively of this Presidency. Similarly, in regard to ground-nut, pepper, jute, cholum, Indian corn and fodder-crops, much valuable information has been obtained.

The manuring of paddy and the scientific feeding of cotton are at present receiving the special attention of Mr. Harrison, the Agricultural Chemist, and Dr. Barber, the Economic Botanist, at this Institute. I mention this specific instance to show Your Excellencies the practical spirit in which the experts of the Department are attacking their problems.

But when research has done its work, and can point with confidence to definite lines of improvement, the problem of how to influence the ryot will have only been half solved. It is in order to provide an efficient Indian agency for taking up the work at this stage and carrying it into the villages and fields that the Agricultural College has been founded. The District Agricultural Associations, some of which have been doing excellent work, are clamouring for such an agency, and Your Excellency is frequently asked to establish new Agricultural Stations which for want of qualified men to work them cannot for the present be started. While it is our ultimate hope that experts qualified for Research work will receive at all events part of their training here, it is primarily the practical expert that we hope to produce from the Agricultural College. The course of instruction will last three years, and embrace Chemistry, Botany, Physics, Veterinary Science, Agricultural Engineering and General Agriculture. Twenty students, as already stated, will be admitted each year, making a total of sixty when the College is full. The second batch of students has recently entered the College. When the time comes for the student to receive the Coimbatore Diploma in

Agriculture and, I trust that it will be the ambition of every student to win it by dint of untiring industry and application, it is hoped that he will have a knowledge of the sciences on which the art of Agriculture is based sufficient to make him an intelligent, helpful and friendly critic of the ryots' ancestral methods. Special attention is also being paid to the practical side of his training, so that he may understand the actual difficulties under which the ryot labours, and may, if need be, show him how to meet them. In order to combat successfully the practical objection which the ryot is so fertile in raising, he must himself have a thorough knowledge of all the details of cultivation. It is mainly to provide the students with the opportunity for acquiring this absolutely essential practical knowledge that this large tract of fertile and highly cultivated land has been added to the College, embracing, as it does, wet land, irrigated dry land, and purely rain-fed dry land, it is admirably suited for the purpose.

The rules which have been sanctioned by Your Excellency's Government for the admission of students to this College have steadily kept in view the need for attacting practical men rather than mere students. Special care has been taken to profit by the experience of the past and to avoid the danger of attracting an unsuitable type of men ready at the first opportunity to drift into any line of life rather than adopt the profession of an up-to-date farmer. No scholarships are therefore granted, and no promise of employment in Government Service is held out. The ordinary standard of education expected is the Matriculation examination, but where the applicant can satisfy the Principal that he is a suitable student in other respects, even this standard is not insisted upon. In order to render the College as accessible as possible to the sons of the poorest ryots, no fees are charged for the use of the hostels. The students provide their own food and can thus regulate their expenses according to their individual means. The hostels themselves have been built in ten separate blocks, each accommodating six students, so there need be no difficulties in the matter of caste.

I trust this brief summary of the aims and objects of our Agricultural College and Research Institute, and this description of the means which have been adopted to secure them will have satisfied Your Excellency that the large sum of money expended on this magnificent College and Farm has been well laid out. But just as walls without men do not make a College or centre of Research unless the men who work in them are inspired by the proper spirit, I have, therefore, much pleasure in assuring Your Excellency that the enthusiasm with which the expert staff of the Department, European and Indian alike, have entered upon their new duties, justifies the most sanguine hopes that their labours will be fruitful and will tend to the material advancement of our mutual friend and paymaster, the man behind the plough.

It only remains for me to thank Your Excellencies for your patient attention to these explanatory remarks, and to invite you, Sir, to be so good as to open our Agricultural College and Research Institute by unveiling the slab, whose inscription will record for this and every succeeding generation the intimate connection of Your Excellency with the establishment of an Institution founded for the express purpose of improving the material condition and increasing the happiness of millions of our Indian fellow-subjects.

His Excellency in the course of his lengthy reply said that it was with very sincere pleasure that he proceeded to comply with the request which had been made to him by the Hon'ble Mr. Castle-stuart Stuart, viz., that he should perform the ceremony of declaring this College to be duly opened. It was indeed with great satisfaction to him to find himself that day, because he took the very deepest interest in the welfare of this Institution. His Excellency rejoiced to know that his name was to be associated with this institution from which students will be trained and sent out to carry on this useful purpose. The address which was read by Mr. Stuart was full of interest, and allusion was made to the fact that it was His Excellency that performed the ceremony of laying the foundation-stone of that very College that seemed to him to have occurred only the day before yesterday, and yet His Excellency realised that that ceremony took place during the first half year of his career. His Excellency was performing that day the final ceremony of the opening of the College, and His Excellency was grieved to find that it was during the second half of his administration, and that the time had gone so quickly. Still he would watch the success of this institution even when he left the shores of India. He congratulated those who were responsible for this object as well as those who took part in the construction of this building. His Excellency congratulated them more

because, as they heard just then, that success had been achieved amidst considerable difficulties. His Excellency hoped that nothing had been omitted which might be required for the training of students and for the experiments of all kinds of practical as well as scientific Agriculturists.

At the same time the Government would not hesitate to increase the capacity of this Institution just as they pointed out in their address. The Government had already expended a large sum of six lakhs for this College. The Government of India in the interests of the ryots had been doing much in this direction. His Excellency then spoke at length about the benefit and advantage of the British Rule in India, and said that under British Government there was justice between man and man as far as possible, as the Government had not forgotten the interests of the ryots, and this work had been taken purely for agriculturists and cultivators of this land. The Estates Land Act was for their good, and it was a matter for regret that the Hon'ble Mr. Forbes who did so much had now retired. It was in the interests of ryots that they found themselves in their midst, and Mr. Stuart had given a short sketch of the efforts that had been made in this Presidency to improve methods of agriculture. It was only in recent years that a change had taken place in the matter of agricultural science. The difficulties were great, and they must try to surmount those difficulties. It seemed to him that Agriculturists had now taken not only cultivation of lands but also culture of those who lived on them. By culture, His Excellency meant the enlightenment of the discipline which is acquired by manual training, and had nothing to do with the mischievous interpretation of that phrase. It was universally recognised that agriculture to-day meant the cultivation of people who were in it. There must be intelligent and proper efforts if a ryot wanted to succeed in manuring and increasing the fertility of the soil. His Excellency here quoted the example followed in Canada in this respect. It was extraordinary to observe what a marvellous advantage science had made in this country, and not only science has advanced but also the material prosperity in the research investigation. It was easy that any difficulty in this direction might be overcome. His Excellency hoped that young men in the College would be educated to a higher conception of the standard of living in this direction. It seemed to him that the field of research was practically limitless. His Excellency next spoke about the duties of professors who ought to train students here. The Government he said would like to admit only those students who would make agriculture their life work and would refuse admission to those who want to join the Government service other than the Agricultural Department.

SOME INDIRECT BENEFITS OF IRRIGATION NOT GENERALLY RECOGNIZED.

By Henry Marsh, C.I.E., M. INST.C.E., Consulting Engineer, Protective Irrigation Works, Central India.

(From the *Agricultural Journal of India*, Vol. IV., Pt. 1, January, 1909.)

Many people think that Irrigation from canals, wells, and tanks is only of use as a protective agent in tracts of precarious or slight rainfall. They know, of course, that millions of acres have been reclaimed from desert by the harnessing of rivers in the Punjab, in Sindh, and in Egypt. But they are probably not aware of the many indirect benefits which accrue to the State and agriculture from the presence of unfailing irrigation even when the rainfall is fair to good. In this article it is proposed to deal with the advantages which are thus derived, and though not patent to the public, are well known to revenue officers in Upper India.

2. Before going into details, it is well to summarise these unconsidered assets as follows :—

(*a*) Power of substituting immediate sowings in case of destruction to advanced crops, or harvests.

(*b*) Diversity of cropping, *i.e.*, insurance against losses.

(*c*) Maintenance of cultivation, and demand for labour throughout the season.

(*d*) Presence of fodder, pasturage, and water for cattle.

(*e*) Improved sanitary conditions.

(*f*) General increase of comfort, well-being, and decrease of crime.

Power of Substituting new Sowings in case of Accidents to Advanced Crops or Harvests.

3. The last two decades have afforded many melancholy opportunities of observing injuries to crops, which were giving splendid promise of bumper harvests. In 1904-05 the autumn sowings had been unusually extensive, and the winter rains had benefited them

to such an extent that prospects were exceptionally good. However, three or four days of extraordinary frost in the beginning of February, 1905, completely changed these happy conditions. All advanced crops were utterly ruined, and where the peasants had no irrigation to water the fields, their plight was very serious. They simply had nothing to look forward to, until the following monsoon would enable them to sow kharif grains. In Bundlekund the rain did not come at all, and thus misfortune followed misfortune. The case was, however, very different with the irrigating tenants. The ruined wheat fields were quickly ploughed into the soil, and sown with "zaid" crops, *i.e.*, "chehna" (*Panicum miliaceum*), vegetables, melons, etc. The cultivation of "chehna" proved to be a very sound enterprise, as it ripened in two months, and produced five or six maunds of grain to the acre. Other tenants got the land ready for sugar, if they had the necessary manure. Others prepared it for April sowings of maize, jugar, cotton, and hot weather rice. Maize sown at this period produced cobs in July, and fetched ready money in the local markets. Early cotton plants were well advanced, when the monsoon arrived, and were therefore not liable to injury from flooding. This form of cultivation is largely replacing the indigo of the Jumna and Ganges Canals, and requires every encouragement. It enriches the land and produces a better class of fibre. Irrigation was also the cause of other benefits in this phenomenal frost calamity of February, 1905. Fields that had recently taken water escaped almost entirely. I was Chief Engineer of Irrigation at the time in the United Provinces, and remember well having to run the Canals, although the executive staff wished to have them closed for urgent repairs. The water thus given had a most beneficial effect in resuscitating crops that were seemingly killed by the excessively low temperature. After a short period of, so to speak, hibernation, they recovered, and gave very fair returns. In Muzaffarnagar and Saharanpore, where frost is a common occurrence, the cultivators are constantly on the lookout for it in the winter months, and freely irrigate the young crops to prevent mischief. They attribute the protection to the thicker and stronger growth of the irrigated plant. This idea is similar to that held by cultivators of unirrigated soils. They rejoice exceedingly when propitious rains arrive before the frosty season. Experience proves that the young rabi is much strengthened by the damp, and thus able to resist subsequent low temperatures. So far I have only dealt with the case of the calamitous frost in 1905, and have shown that the irrigating tenant was in a position to retrieve his losses by fresh sowings. But the same reasoning applies to other agricultural disasters. Hardly a year passes, in which the Gazettes do not record the devestating effects in some parts of the country from locusts, hail or rust. In the report on the famine of 1895-96-97, it is recorded that the drought of these years merely completed the agricultural ruin, caused by the excessive winter rains in 1892-93-94. In the last-named seasons immense sheets of spring crops were destroyed by blight. Lowlying lands were too wet for cultivation. Even where the wheat and barley had ripened, and had been cut, the unseasonable rain and storms damaged the grain on the threshing floors. Independent of these well-known calamities, cultivators of tracts near forests or jungles frequently find their fields eaten up in one night by a herd of Nilgaï or Deer. Here, again, the case of the owners is black indeed, if they have no means of resowing crops until the following monsoon. I have recounted all these calamities, to show how many trials beset a cultivator, and how speculative are his chances of harvest profits, unless he has the means of renewing his sowings without delay.

INSURING ADVANTAGES OF IRRIGATION (*i.e.*, DIVERSITY OF CROPPING).

4. All wise agriculturists agree in the advantage of cultivating a variety of crops, *i.e.*, "in not carrying all the eggs in one basket." The Indian peasant follows out this idea in a rough way, by sowing various mixtures, which is not always the best form of insurance, as it depreciates the market price of his grain. Thus, rice and *kodo*, gram and wheat, peas and barley are cultivated at the same time, and in the same field. There are many other combinations, but the main idea is, that dry weather will suit one plant, and a rainy season the second; hence some measure of success may be expected. Where irrigation exists, the position of the cultivator is much sounder. Continuous and heavy rain, which is disastrous to cotton, millets, and cold weather cereals is advantageous to sugarcane and rice. Without irrigation these valuable crops are rarely attempted, except in lowlying lands. This form of insurance is very sound, and is proved by the fact, that remissions are almost unknown where sugar-cane and rice are cultivated and irrigated. They flourish mostly in

damp, cool climates, but require water to mature them. Contrary to general opinion, it is in these climates that Irrigation Projects pay best. Proof may be given by quoting the following extract from page 87 of the Sarda Canal Project of 1903.

"Hence the annual value of a cusec is much higher in the moist doabs of the Eastern Jumna Canal than in that of the drier and hotter country, watered by the Lower Ganges Canal. For the last five years they stand thus :—

VALUE OF CUSECS.

		Eastern Jumna Canal. Rs.		Lower Ganges Canal. Rs.
1898-99	...	1,172	...	571
1899-00	...	1,215	...	704
1900-01	...	1,029	...	558
1901-02	...	1,187	...	636
1902-03	...	1,232	...	705

It is also urged that the revenue will not develop as rapidly as is anticipated on account of the slow progress of the Agra Canal. Here, again, it may be pointed out that the great dryness of the country watered by the latter work has been a bar to the cultivation of first class crops."

MAINTENANCE OF CULTIVATION, AND DEMAND FOR LABOUR THROUGHOUT THE SEASON.

5. These results of irrigation are very important, and are well understood by Collecters who have held charge of protected and unprotected districts. In the former, they know that agricultural operations never cease throughout the year; the labourers never have a slack time and are continually ploughing, sowing, weeding, reaping, or threshing. Crime is greatly reduced, and in seasons of drought, the demand for labour is all the greater. Examining the operations of the year, we find that in January and February the ground is being prepared for sugar sowings, whilst the matured cane is being harvested and the juice expressed. The rabi crop requires great attention. Weeding, watering, fencing, and keeping off marauding animals occupy a number of hands. Harvesting of the rape or mustard is carried out in February; picking the plants and expressing the oil absorb a good deal of labour. In March and April the cutting, carrying, and threshing of the rabi is in full swing, and labourers are at a premium. Much difficulty is experienced in finding hands to hoe and tend young sugar. Moreover, the fallow land has to be irrigated for maize, cotton, juar, or hot weather rice. In May the threshing out is still often incomplete, and the young irrigated crops require much attention. In June, July, August and September, if the monsoon is good, ploughing, sowing, and weeding occupy many people; early crops of maize and rice are cut and garnered. If on the other hand the monsoon is a failure, labour is in strong request to push on irrigation for sowing food crops, and for saving standing crops. October, November and December are absorbed in sowing the rabi, in irrigating it, and in completing the kharif harvest. Thus it is easy to see that in a well-protected country, labour is in demand throughout the year, peasants have little time to indulge in lawlessness, or in following out the freebooting instincts of their ancestors. For 31 years I served on the Ganges and Jumna Canal system; and though many famines and scarcities visited Upper India during that long period, I never saw a famine, and never saw famine labourers at work. Indeed, my great difficulty was to find hands to carry out the many sanctioned projects for new canal branches and drainage works. But during the short period in which I toured in Central India, I was brought face to face with grim starvation, and aimless wandering in two seasons out of three. This is strong testimony to the policy of pushing on protective works. It is surely better to spend money in constructing canals, tanks and wells, even though a productive return is not expected than to await famine, distress, epidemics, etc., and spend large uneconomic sums in relieving them. In the latter case the outlay is often greater, the country is pauperized, officials are over-worked, and seldom do we find any permanent result arising from all the harassing trouble and strain on State resources.

PRESENCE OF FODDER, PASTURAGE, AND WATER FOR CATTLE.

6. Those who have experienced a severe drought can hardly have forgotten the terrible mortality amongst cattle. I have seen thousands of the weary emaciated beasts, driven along the Bombay road towards Malwa in 1905 and 1906. Rain seldom fails in that country, and hence it has earned a great reputation as a place of refuge in times of famine. Similarly, in 1899-1900 I have seen large herds driven from Rajputana and the Punjab to the Ganges khadir, and the Kumaun Terai. In all these disastrous trekkings, many losses were incurred, and bones of the wretched animals, lying along the roads, were silent witnesses to the fact. Independent of these casualties, wholesale butchering was practised in some localities. At Kunch in Jalaun, thousands were dis-

posed of in this way. The owners sold them for a trifle, and the contractors made some profit from the skins and bones. The loss to the country must have been immense, and Government was obliged to advance large sums to the cultivators. Without this assistance, ploughing in the succeeding monsoon would have been seriously affected.

Where irrigation exists, all this horror is avoided. Water is of course plentiful, and so is the straw of all the cereal crops raised by the canals. The banks of the channels afford a certain amount of grazing, whilst spring level rises high in low lands, and causes a plentiful growth of herbage. This latter point is very important. In the valleys below tanks the grass is permanent and of great value. For miles below the embankments useful streams trickle along, and are a blessing to man and beast. The rise of spring level is also of immense use in rendering well-water accessible. This matter is, however, seldom realized until a tank embankment falls into disrepair, and the commanded wells become useless.

IMPROVED SANITARY CONDITIONS.

7. Years ago it was thought that canal irrigation must be the cause of many forms of disease, to which natives and Europeans are liable, in a tropical climate. The belief bore good fruit in one way, as Government sanctioned large sums of money for the execution of drainage works. Remedial measures in the way of reduction of excessive watering were also carried out. More branches, and more distributaries were constructed, and this wise policy acted as an effectual safeguard against useless irrigation and water-logging. Cultivators who were accustomed to deluge their fields weekly are now fortunate if their turn comes once a fortnight, or once a month in times of low volume. This is all good for the land and for themselves. Still, one famous Sanitary Commissioner was rabid on the subject, and pressed the Local Government of the North-Western Provinces not only to close up some canals, but to desist from further extensions. When the case was referred to the Secretary and Chief Engineer for irrigation, he pleaded that canal-irrigated villages would show a better return of health than those of unirrigated villages in the same latitude. He considered this would be the case, as the inhabitants of the former were better clothed and better fed. Investigation proved that the Chief Engineer was right, and the matter was allowed to drop. Very little argument is required to show that though fever may be caused by irrigation, the sanitary advantages far outweigh the disadvantages. Natives live largely on dairy products, and it is therefore necessary that milch cattle should have good drinking-water. Without canals, streams, or large tanks this essential does not exist. The conditions in which some beasts have to quench their thirst in offensive village ponds are no doubt a danger to the public. Milch cattle have power to pass off poisonous ingredients in their milk, and thus it is easy to conclude why many outbreaks of disease take place in drought-stricken tracts. A well-known case of this kind occurred in Gloucestershire some thirty years ago, when a number of people were invalided, by consuming the milk from a certain dairy farm. Subsequent investigation proved that the bullocks and heifers on the land were sick, and dying, whilst the cows which produced the deleterious milk were thriving. This fact gave the clue, and it was then discovered, that for the sake of salt, the beasts had been licking a keg of poisonous paint which had been left in the meadows. The cows did not suffer, as they passed off the poison in the milk; the other beasts sickened and died. Very possibly similar reasons produced the terrible scourges of cholera which used to rage in the Meerut and Agra Divisions before canal irrigation was introduced. The memorial stones on the camping grounds, giving lists of officers and soldiers who died from the disease forty and fifty years ago are strong proofs of this conclusion. Such epidemics seem to have quitted this highly irrigated part of the country, and it may be claimed that the immunity is due to the presence of the flowing water in the canals. Nothing is so deadly as a scarcity of potable water in a tropical country. It has been very truly said that more lives are lost in India from want of water than from want of food. There is another great advantage in the introduction of canal water from the large rivers. Wells in Muttra and Agra Districts, that used to be brackish, have now become sweet. This is a great joy to the people, who used to struggle for vessels of potable water at the few wells which were not bitter.

GENERAL IMPROVEMENT OF THE PEOPLE AND COUNTRY.

8. In this paragraph an attempt will be made to indicate the general benefits which arise from the improved conditions already explained. The cultivators who are well placed, as regards irrigation, gradually reach a stage of assured financial stability. Though they may not obtain heavy harvests in years of

drought, and though some crops may be lost by reason of various calamities, yet a portion of sowings will come to maturity, and splendid prices will be realized. In this way, the tenant clears off all debts, builds a better house for himself, keeps better cattle, and finds no trouble in marrying off his children. Altogether a better state of well-being is arrived at. Rents come in regularly, and instead of the headmen felling the mango groves, new plantations are laid out, and new wells are sunk. The population increases, the waste lands are reclaimed and brought under the plough. In time, villages comprising a few huts will become quite large towns connected with centres of trade by roads or railways. The advantages derived by Government are most important. The land revenue becomes stable, and advances are not required to tide the tenants over bad seasons. The people who are dacoits and cattle lifters become respectable, law-abiding members of society. Instead of spending large sums in maintaining peace, the State has to consider schemes for roads, hospitals and schools. The increased wealth of the people leads them to make long pilgrimages, and the facilities of travelling must exercise a strong educative effect. It has been said with considerable truth that after all a railway engine is the best school master. Railways themselves benefit enormously by the prosperity of the cultivators. The exports of produce increase by leaps and bounds, and returns do not fall off in irrigated tracts, as they do in unprotected countries. India is mainly an agricultural country; nothing is so necessary to her as the development of irrigation facilities, and prevention of the wasteful escape of river water to the seas. Not only do these protective works afford food and occupation for millions, but the climate itself is modified beneficially. Intense aridity is checked, and healthful dews are created, which assist in the growth of herbage and trees. The Monsoon rains descend on levelled fields covered with young crops, and the latter act as powerful agents in preventing denudation, and limiting excessive floods in the main rivers. Mr. Buchanan, Under-Secretary of State for India, has evidently grasped the advantages of developing irrigation works, and has impressed them on the House of Commons in his recent Budget Speech. He said: "There is no sphere of work in which the Indian Government has been engaged, which is more satisfactory to contemplate than that of the railway and irrigation work." . . . . . "I have given notice of a bill for renewing our power of borrowing money for railway, irrigation, and other general purposes, but I have not yet had the opportunity of introducing it. It is a measure, however, that will generally commend itself to the approbation of the House, and from it we may expect very excellent results will ensue. Every one will regognize also, that there is no part of our work which reflects more credit on us than the admirable irrigation work, large and small, which has been carried out in recent years. It has been a help to our revenue, tending also to mitigate the condition of the poorest people in their distress. We intend to go on in the future in pursuit of that policy."

GREEN MANURING.

(From the Supplement to *The Nyasaland Government Gazette* of 30th June, 1909.)

This is one of the most discussed Agricultural problems of the present day, and has its foundation in Hellriegel's discovery of 1886, when he declared and proved that plants belonging to the Natural Order *Leguminosæ* were capable of utilising atmospheric nitrogen.

This special power of assimilating nitrogen from the atmosphere of the soil surrounding the roots is the result of a symbiotic relationship between leguminous plants and the bacteria known as *Bacillus radicicola*.

If one examines the roots of a leguminous plant, such as a bean or a pea, it will be noticed that the rootlets are covered with swellings, those swellings or nodules are the result of the irritation set up by the *Bacillus radicicola* which inhabit them.

The bacteria enter the young rootlets from the soil, and receive from the plant the starchy food necessary for their lives, and in return give the plant their excreta and dead bodies which are rich in nitrogen.

If the bacteria received from the plant all their food they would be parasites, but as they have the power of using atmospheric nitrogen for building their own bodies they are not parasites. The relationship between the two is symbiotic, as each benefits the other; the plant supplies to the bacteria the starchy food which they could not make, and in return the bacteria gives to the plant a complex form of nitrogenous matter made from atmospheric nitrogen which the plant could not otherwise utilise.

Now that the relationship is explained, it is possible to consider the problem from a practical point of view. All plants, no matter whether Cotton, Coffee or Rubber, absorb from the soil nitrates,

sulphates and phosphates of calcium (lime), magnesium, potash and iron, but they absorb them in different proportions depending on the family or order to which the plant belongs.

One point must be borne in mind, that if one of those constituents is absent no plant can grow; they are all necessary for the building up of plant tissues, and one constituent cannot displace another in this work.

Under normal conditions they are all present in the soil, but sometimes there is a deficiency of one or more of them, and those deficient are usually the nitrates, the phosphates, the potash or the lime, hence in manures those form the principal constituents.

In all questions relating to manuring it is imperative to remember that the size of any crop is determined by the constituent of plant food present in least amount. For example, if an acre of ground contain a surplus of all the above constituents and less nitrogen than that required for a maximum crop, the return would be in proportion to the nitrogen present, as the plants could not utilise the surplus of other constituents when it had no nitrogen to combine with them.

In Great Britain, as every one knows, crops are grown in rotation, and as different crops use different proportions of the essential plant-food constituents in the soil, there is little fear of soil exhaustion. Under those conditions the land is producing a crop, and at the same time recuperating in the constituents required for the following crop by the natural agencies of soil decay.

This may be explained by making a comparison of the amounts in pounds of nitrogen, phosphoric acid and potash removed by crops of Cotton, Corn, and Wheat:—

Crop.	Nitrogen.	Phosphoric Acid.	Potash.	Totals.
Cotton—				
190 lbs. Lint ..	·65	·19	·87	
414 lbs. Seed ...	12·95	5·26	4·84	
Total ...	13·57	5·45	5·71	24·73
Corn—				
29·4 bus. Grain ..	32·14	12·36	7·06	
Stalks ..	41·60	11·60	56·00	
Total ...	73·74	23·96	63·06	160·76
Wheat—				
13·95 bus. Grain ...	19·55	7·44	5·10	
Straw ...	13·57	2·76	11·73	
Total ..	33·12	10·20	16·83	60·35

From the above it is seen that Wheat requires more than twice and Corn nearly seven times as much plant food as Cotton.

It will be noticed in all three crops that nitrogen is absorbed in the largest quantities. Green manuring is the least expensive manner in which to restore this nitrogen to the soil.

In Nyasaland Maize and Millets are the most extensively cultivated of all the crops, and it is seen that this class of crop is especially exhaustive of nitrogen.

On the rich lands adjoining the Shiré, those crops can be grown for many years on the same soil, but in the Highlands, the crop soon degenerates in yield, and every few years the native requires to clear new land.

It is a known fact that no soil when subjected to heavy washing will retain soluble nitrogen if there is drainage the low river lands are not washed by percolating water to the same extent as the highlands, where every shower washes the soil to the valleys, especially in the case of light gravel or rocky soil.

There is only one way of fixing nitrogen on sloping soils, and that is by covering the soil with vegetation; during life this vegetation absorbs the soluble nitrogen, and on death forms a covering of vegetable debris which decomposes slowly, and prevents soil washing, by acting as an absorbing and evaporating layer on the surface.

In the tropics it is imposible to grow crops in rotation, as the cost of transport and freight makes it prohibitive to cultivate many of the short-lived crops; and the more valuable crops, such as Coffee, Rubber, Tea and Coconuts, require several years before reaching maturity.

For many years it has been the practice to clean-weed all those plants, irrespective of the situations and climatic conditions under which they are growing. Every planter knows that if weeds are allowed to grow, returns are small and quality poor with all crops. It is not the intention of this article to advise the complete abandoning of clean weeding, as with many crops, such as Cotton, clean weeding is an absolute necessity, but with other tropical crops green manuring is more profitable.

REASONS FOR GREEN MANURING.

On sloping elevated ground it is always noticeable that plants growing at the bottom of the hills are stronger than those at the top, and is accounted for by the nitrogen from the top of the hills being washed to the lowest level,

When new land is opened there is always a large amount of organic matter in the surface soil, the accumulated vegetation of many years; under tillage and clean weeding this vegetation disappears, decaying and returning to the soil. Most of the nitrogen in a soil is contained in this form, and at the end of three years' cultivation, practically no leaves or sticks are to be found, the greater part of the nitrogen in this organic matter has become available and absorbed. Of the remainder the most of it has been washed deep into the soil, or into the drains and lost from the plantation.

It is frequently seen in practice that a first year's crop on newly-cleaned land is poor, the reason is usually excess of acidity produced by the decay of vegetation in absence of air, but after a year's tillage this disappears.

It would not be advisable to sow green manure plants among a crop planted on newly-cleared land, but it would be very profitable and advisable to sow green manure crops among Coffee, Tea or Rubber which was growing on a nitrogen-poverty, rain-washed soil, having been submitted to heavy tropical rain during half the year and drought during the other half, for five or six years; receiving nothing but a hoeing to promote the rapid decay of the few leaves which fall from the trees occupying the land.

One of the great advantages of having organic matter (pieces of plants, etc.,) in the soil is that the organic matter enables the soil to retain soluble nitrogen and moisture and acts like a sponge increasing the power of imbibition.

Take for example the Coffee crop, it is generally accepted that the most critical time is the time of flowering (end of October and early November). If the rains are late, much of the flourish is cast and the result is a small crop. This was the case in Nyasaland last rains, and on a well-known estate I saw fully 100 acres with scarcely a berry. If that soil had been green manured in the previous year, it is very probable that the amount of water retained in it by the organic matter (dead leaves branches, etc.,) from a green manure crop, would have been sufficient to enable the Coffee Plants to retain their flourish until the advent of the rains.

Another point noticeable in the Coffee crop is the damping off or blackening of the primaries. This is usually worst in old trees, and is undoubtedly closely connected with the vitality of the plants. It is generally attributed to thrips, but this is wrong; thrips may cause defoliation, but not the blackening so visible on most plantations in the present year. This blackening off is usually worst on heavy soil, and probably is due to lack of aeration at the roots. Green manuring also helps to aerate the soil, and this is one of the mechanical effects of supply of organic matter in the soil.

The blackening of the primaries, and severity of thrips, have much to do with the condition of the plant when attacked; and if the plants are half starved for lack of nitrogen, or suffocated for lack of air at their roots, they succumb much more rapidly.

EFFECT OF GREEN MANURE ON RUBBER.

It is a general idea throughout Nyasaland that Ceara Rubber is the crop to grow on all exhausted Coffee plantations, but this is a great mistake.

The reason why the public have arrived at this decision is the rapid growth of the Ceara plant, but in the writer's opinion the more rapid the growth of a crop the greater the necessity of having a responsive soil, rich in soluble and available plant-food constituents.

A soil for a quick-growing crop should contain a high percentage of nitrogen, as nitrogen stimulates growth more than any other constituents of a plant's food.

In a cloudy temperate country there is danger in having large quantities of nitrogen, as the growing season is short, and nitrogen retards ripening, but with the sun and dry weather of the tropics, nitrogen in large quantities is always beneficial, as it promotes growth and makes the plants more independent of drought.

In no other country has the writer noticed Ceara Rubber branching so near the ground as in Nyasaland, and this is much more noticeable in Rubber planted in exhausted Coffee estates than in Rubber planted on the river. It seems to the writer that the plants are suffering from lack of sufficient nitrogen and soil drought; principally through deficient organic matter in the soil, and that they are developing this undesirable habit of low branching in order to shade their roots with their own branches.

On some of the highland Rubber estates the Ceara in the first year shoots high and spindly into the air in the wet season, in the month of March flowers, and bears fruit in the first year; when the dry season comes the plant's energy is expended, with the result that it dies back several feet; at the advent of the

next rains the trees send out side branches and produce irregular-shaped trees which never develop a six feet trunk suitable for two or three years' economical tapping.

It has been proved that the flow of latex from a rubber tree is effected by endosmotic pressure which practically means the amount of water in the plant roots.

It is the practice to tap Rubber in the early morning and evening, and to discontinue during the heat of mid-day and early afternoon.

During the heat of day much water is evaporated by the leaves and latex flows slowly, but in early morning and evening water wishes to enter by the root quicker than it is evaporated, with the result that there is an internal pressure which helps the flow of latex, therefore it is practical to assume that there is an intimate connection between the presence of water in the surface soil surrounding the roots, and the flow of latex from the Rubber tree.

For half the year in Nyasaland there is no rain, and daily the sun is strong enough to evaporate water from the plants and from the soil. The question arises, where does this water come from? and the answer is from the lower layers or subsoil by rising to the surface in the form of water vapour and water liquid (capillarity).

In the surface soil of a clean weeded estate the water during day is principally in the form of water vapour, the water being vaporised to a considerable depth by the direct overhead rays of the tropical sun.

In the surface soil of an estate growing a green manure crop there is a large portion of the water in the liquid form, as the covering of vegetation reduces the temperature of the surface soil and prevents the direct penetration of the sun's rays. Therefore, when Rubber is growing surrounded with vegetation, its roots have actual access to liquid water through the greater part of every day.

If we examine the same soil during the dry season after the green manure crop is dead, we still find more moisture in the latter, as the dead remains of the green manure crop absorb and retain water more firmly than ordinary soil, but delivers it freely to the rubber roots although not as freely to the atmosphere.

PLANTS FOR GREEN MANURING.

Any plant belonging to the Natural Order *Leguminosæ* increases the nitrogen in the soil, but the amount of increase depends on the luxuriance of the crop, and whether it is harvested or turned into the soil. Any of the following crops are suitable for this purpose in Nyasaland:—Native Beans, Earth Nuts, Soy Beans, Cowpeas, Lucerne, Egyptian Clover, Crotolaria.

With a green manure crop plenty of seed should be used, and it should be turned under when the crop has reached its maximum luxuriance which is usually at the time of flowering, a small portion of the estate being left to produce seed for the next season. The advantage of turning under before ripening is that the crop decomposes more rapidly as the tissues always lignify (turn to wood) after the flowering stage has been reached.

The most desirable characters in a green manure crop is abundance of bulky nitrogenous vegetation contained in soft and easily decomposable tissues. All the above crops except Crotolaria are useful cattle foods, and some of them are exportable, but, of course, if the seed is exported the manuring benefit is reduced.

Crotolaria striata is the green manuring plant most highly favoured in Ceylon and the Federated Malay States for Rubber; an experiment in Ceylon showed that 14,000 lbs. of organic matter per acre was produced and was estimated equal to 700 lbs. of nitrate of soda. Nitrate of soda costs 10*s.* per 100 cwt. in England, and the seed costs $3\frac{1}{2}$*d.* per lb. in Ceylon, 5 lbs. per acre being sown; there must be profit when we also consider that the cost of weeding was reduced to a minimum.

Egyptian Clover or Bersim (*Trifolium Alexadrinum*).—This is the green manure crop of Egypt, where it is grown twice in a three-year rotation with Cotton.

It is rightly held by most authorities that the high yield of Cotton in the Delta is the result of using this highly valuable nitrogenous Clover as a manurial basis for the cultivation of Cotton crop.

The amount of green forage per acre produced is as much as 7 tons per cutting, and frequently four cuttings are obtained in six months, and fed to cattle on the land, the manure and urine being returned to the soil,

Earth-Nuts.—It is very questionable if much benefit is obtained from this crop when the nuts are gathered and exported, but if the crop is turned in at flowering stage, there are few better crops for green manuring.

It is not advisable to leave it till ripe as the high percentage of oil in the seed

makes it decompose very slowly, and oil itself has no manurial value, not being absorbed by plants.

PRECAUTION.

Before sowing a crop like Cotton, green manures must be turned down at least two months, or they will interfere with the germination of the seed.

The same applies to the opening up of new land, and it is nearly always advisable to turn under all surface growth at least two months before planting. Some plants can stand this fermentation better than others, it does not seem to influence Maize to any extent, and it is generally better to grow Maize for the first year on new land rather than Cotton.

SUMMARY.

1. Green manuring conserves moisture in the surface soil, and makes plants drought-resistant.

2. Additions are made to the nitrogen of the soil, a constituent usually deficient in Tropical soils.

3. Soil washing and loss of soluble nitrogen is reduced to a minimum.

4. Plants are stronger and more able to resist fungoid diseases and insect attacks.

5. Growth is healthier, and crops give better retuns.

6. The life of the plant is longer, and the soil is more capable of supporting it.

7. Weeding is reduced to a minimum, and hence cost of production.

REPORT ON A VISIT TO INDIA AND CEYLON.

By H. POWELL.

(From the *Agricultural Journal of British East Africa*, Vol, II., Pt. I., April, 1909.)

The visit to India and Ceylon was undertaken on the recommendation of the Honourable the Director of Agriculture with the approval of His Excellency the Governor and His Majesty's Secretary of State for the Colonies.

The object was to enquire into the methods of agriculture carried on in those countries, more especially as regards rubber, cacao, tea, rice and such other tropical and sub-tropical products as might be likely to succeed in this Protectorate, and to obtain plants and seeds of economic importance for trial at the Government Experimental Farms.

I arrived at Bombay from England on January 1st, 1909, and left the same port on the return journey to Mombasa on February 18th. The actual time spent in India and Ceylon was only forty-eight days, but owing to the extremely favourable railway and other travelling facilities provided, I was able to undertake the greater part of the journeys by night, thus leaving the days free for observation and study.

The centres visited in India were:—Bombay, Poona, Nagpur, Calcutta, Pusa, Darjeeling, Madras, Bangalore, Tuticorin; and in Ceylon:—Colombo, Henaratgoda, Peradeniya, Kandy, Matale, Hatton, and Nanuoya. Under the heading of most of these centres will be found remarks regarding agriculture, horticulture or botanical subjects which, it is hoped, will prove of interest and use. Every facility for obtaining information was afforded me by the officials of the Governments of India and Ceylon as well as by the proprietors and managers of the various plantations, etc., inspected, and by private persons, all of whose kind help was highly appreciated.

Ceylon is a veritable tropical planter's delight, and I regretted that time did not admit of my seeing more of the agriculture of the Island.

The vegetation is of a luxuriant rank nature, and the intensive cultivation as seen in the case of tea, rubber, cacao, etc., can perhaps scarcely be surpassed; the agriculture generally being of a very high order.

In India it is very apparent that a great forward movement in agriculture and its kindred branches is now going on. The work being done by scientific and technical experts at the great centres is doing much to encourage better methods of cultivation and preparation of produce among the small holders in the outlying districts.

A special feature in connection with Indian Agriculture is the "Water Buffalo." As a draught animal and for general field work this beast appeared to be indispensable, and was seen in considerable numbers almost everywhere.

Lists of seeds and plants obtained in India and Ceylon are submitted with this report.

As will be seen from these lists the collection of plants and seeds is of an extensive and comprehensive nature, and will be the means of adding many tropical and sub-tropical species of economic importance and beauty to East Africa.

VICTORIA GARDENS, BOMBAY.—These fine gardens are an immense attraction to the residents of the great city of Bombay, and deservedly so, for the grounds, which cover several acres, are very suitably laid out and contain a great variety of tropical trees, shrubs and plants. The plant houses are stocked with ferns, choice foliage and other plants, and the whole institution evidences great care in its general upkeep.

A large assortment of economic and general plants is kept in the nurseries for purchase or exchange. By the latter methods two cases of plants were secured for Mazeras, through the kindness of the Superintendent.

The nearness of Bombay to Mombasa, as well as the means of communication between the two ports, renders the importation of plants to East Africa a matter of little difficulty and to those desirous of importing tropical plants, the Bombay Gardens are recommended as a reliable source. A catalogue showing what plants and seeds are available, with prices attached, is issued there.

POONA.—A visit was made to the Ganeshkhind Botanic Gardens, Kirkee, near Poona, where special attention was being given to the preparation of various fibres by means of retting, with good results, though the process is somewhat slow.

In this district large numbers of Agave Cantula, similar in appearance to the Sisal Hemp, were seen to be "poling," and millions of bulbils were available.

The plant is said to produce what is known as "Bombay Aloe Fibre," which is considered inferior to Sisal Hemp.

Much useful work of a general nature is being carried on at the Ganeshkhind Experimental Station.

The Empress Garden at Poona was also visited.

For extreme neatness and the great variety of pot plants, no prettier garden was seen anywhere, but nothing in the way of experimental work is attempted.

From Bombay to Poona the railway passes over the celebrated "Ghauts," acknowledged to be a marvel of engineering, and in places the traveller looks down over precipices of hundreds of feet into the valleys and plains below.

Rice is grown in places on the plains, otherwise the country in the neighbourhood of the "Ghauts" is of little use for agricultural purposes.

NAGPUR (*Central Provinces*).—My visit here coincided with the holding of an Agricultural and Industrial Exhibition on a large scale.

The exhibits were of a very comprehensive nature, and included agricultural and other implements of various types as well as manufacturing plant. Working trials of the implements and machines were made at stated times, in which the natives and others took a keen interest.

A small sugar "plant" including a centrifuge for separating the molasses from the sugar was in frequent use and specially interested the natives; many of whom were anxious to obtain a duplicate. The makers are Thomas Broadbent, Huddersfield, England.

To those ordering the "plant" the advice was tendered that the pattern should be that supplied to Mohammed Hadi, Assistant Director of Agriculture, United Provinces, as this contained important improvements especially as regards the centrifuge.

The collection of unginned cotton, oilseeds, rice, wheat, pulses, etc., were representative of the various districts, and were of special merit.

Another instructive set of exhibits contained different types of soil with the chemical analyses of the same, and the porosity of each soil was illustrated by means of large glass tubes.

Mr. Hemingway, the Director of Agriculture, took much interest in assisting me to inspect and obtain information at the exhibition and other places under his control.

A visit was made to the Government Experimental Farm at Nagpur, where special attention is being paid to wheat, cotton, forage and other crops. An improved type of "Georgian" Upland Cotton was found to do extra well at Nagpur, and it is likely to further encourage cotton growing in the Central Provinces.

By permission of the Management I went over the Empress Cotton Mill at Nagpur with Mr. Hemingway. This is the largest Cotton Mill in India, employing about 6,000 hands and paying high dividends. Here the whole process of spinning and weaving can be seen in a short space of time.

The mill uses a large amount of American cotton for mixing with the short staple Indian cotton.

A collection of the pulses, rice, and oil seeds grown in the Central Provinces was kindly promised me by Mr. Hemingway.

CALCUTTA ROYAL BOTANIC GARDENS, SIBPUR.—These splendid gardens are one of the great delights of visitors to Calcutta.

Situated some three or four miles down the Hooghly River they are not so easy of access as one could wish, though recently the facilities for reaching them have been much improved.

The grounds are large and studded with beautiful and varied botanical treasures from many tropical lands. Both the nursery and plant houses abound with useful and decorative plants, and an herbarium of first-class botanical importance is at the disposal of botanists for purposes of study and research.

An object of much interest is the large Banyan Tree in the gardens, on which is the following label :—

"FICUS BENGALENSIS" (BANYAN), NATIVE OF INDIA.—"This tree is about 139 years old. Its circumference 5½ feet from the ground is 51 feet. Circumference of crown 997 feet. Height 85 feet. It has 562 ærial roots naturally rooted in the ground."

The Director, Dr. Gage, kindly supplied me with a large collection of seeds, and later, a case or two of various plants desired will be obtained from the same source.

The tastefully laid out and well-kept pleasure grounds around the Viceroy's residence and various muncipal gardens in Calcutta were inspected in company of the Superintendent in charge.

The Zoological Gardens in Calcutta are well stocked with beasts and plants, and attract many visitors.

AGRICULTURAL RESEARCH COLLEGE, PUSA.—On no account should anyone interested in agriculture and general research work omit to see Pusa during a visit to India.

The extensive establishment is well equipped with laboratories and general research facilities, and is conducted on the most up-to-date principals.

I was courteously accompanied through the various scientific sections by the Director, Mr. Bernard Coventry, and was afforded much information on several interesting subjects.

I also had the pleasure of meeting Mr. Maxwell Lefroy (Government Entomologist) and Mr. Albert Howard (Economic Botanist) two of my former colleagues in the Imperial Department of Agriculture, West Indies.

Much valuable work is being done in the experimental grounds. Many wheats are under trial and form a striking feature of the place.

The fruit trial grounds are also of much interest, and include peach, plum, loquat, litchi, orange, fig, etc.

Various methods of treatment are carried out, and much of the success of the good bearing qualities of the several trees is secured by a judicious exposure of the roots, careful pruning and manuring. A complete system of irrigation extends over the whole of the experimental grounds.

Seed of several economic plants was secured with the promise of further additions.

Mr. Maxwell Lefroy showed me his simple device for ridding rooms of mosquitoes. It consists of an ordinary box about 18 inches high by a foot in breadth and width. The inside is lined with a dark coloured material and the box is made practically airtight by means of a close-fitting door. When required for use it is placed in the darkest corner of the room, and every night and morning a small quantity of benzine is placed inside the box, the lid closed and the mosquitoes which have settled therein are killed. In this way Mr. Maxwell Lefroy captured upwards of 2,000 in a single month.

Pusa and the country for many miles around was the centre of the thriving Indigo industry until the manufacture of artificial dyes made indigo growing unprofitable ; planters have difficulty in finding a suitable alternative industry.

Tobacco does exceedingly well, many fine fields of carefully tended plants being seen.

Pulses in general do well, also several kinds of oil-seeds. Fibre cultivation is being considered and is likely to be largely taken up.

DARJEELING.—This proved to be one of the most interesting journeys of my tour. The scenery is of the grandest and is constantly changing as the tiny train gradually winds its way by curves and loops up the slopes of the Himalayas, where many tea plantations are established.

At the time of my visit, which was about the height of the cold season, the weather was mostly wet, foggy and cold.

Judging from the climatic conditions and the appearance of the country as well as the condition of the tea bushes I am led to believe that tea growing should prove successful on parts of the Molo and surrounding country of the Protectorate.

The well-kept and interesting garden known as "Lloyd's Botanic Gardens" at Darjeeling was visited and many plants new to me were seen.

MADRAS.—On arrival here I called on Dr. C. A. Barber, Government Botanist in charge of the experimental farms.

Dr. Barber has given much attention to the cultivation and selection of groundnuts, with the result that he has secured a form of the Mauritius groundnut possessing extra good bearing qualities. About 120 lbs. of this seed were supplied me for trial at Mazeras.

Sugar canes of several selected kinds are under cultivation at the experimental farms and are said to have special merit as sugar producers.

Sugar canes of inferior merit are grown in several parts of East Africa where there is a considerable opening for sugar making to supply local wants,

From the Customs return it is ascertained that for the eleven months ending February 28th of the financial year 1908-9 the quantity of sugar or other similar sweetening matter imported into the Protectorate was 36,466 cwts. of the value of Rs. 395,894.

Through the goodness of the Superintendent of the Madras Horticultural Gardens a case of plants and several packets of seeds were obtained as well as a large parcel of seed of the excellent hedge plant "Inga dulcis,"

Guindy, the residence of the Governor at Madras, is the source of the small fine flavoured banana of that name. Some years ago suckers of the "Guindy" banana were imported to East Africa from the West Indies, and are established at Mazeras on a small scale. A dozen suckers were obtained on the occasion of my visit to Guindy.

BANGALORE.—The Botanic Gardens (Lal Bagh) are well known and hold a high place in India. Numerous handsome trees and shrubs are established in the gardens, and large plant structures are filled with well grown pot plants.

Through the generosity of the Superintendent I brought away a case of choice plants and numerous packets of seed. I was also shown over the beautiful garden attached to the palace of His Highness the Maharajah of Mysore, at Bangalore. The various coloured Bougainvillea, of which the gardens have a fine collection, are objects of special beauty.

RICE GROWING.—The visitor to India cannot fail to be surprised at the enormous amount of land placed under cultivation of rice in various parts of the country. Not only is the plant extensively grown where water is plentiful either naturally or by means of irrigation, but huge areas of what appears to be practically waste land are used for the purpose.

The flat land is formed into sections generally in the shape of a square of ½ to 1 acre or more in extent. A bank of a foot or so high is raised around each plot so as to conserve the rain-water, and at the proper time the seed is sown in the ordinary way.

After seeing India it is easy to realise the enormous possibilities for rice growing in the warmer parts of East Africa.

According to the Blue Book the imports of rice into the Protectorate during 1907-8 amounted to 101,164 cwts. from India and Burmah, and 9,058 cwts. from German East Africa, of a total value of Rs. 57,960.

HENARATGODA (CEYLON).—By the kind permission of the proper authorities the conductor of the Government Experimental Gardens at Henaratgoda afforded me much practical information in the tapping of Para rubber trees and after-treatment of the latex and the preparation of "biscuit" rubber.

The Para rubber trees first planted at Henaratgoda are upwards of forty years old. One large plot thirty years old is planted at 12 feet square, but the distance is considered too close. A tree selected for measurement in this plot had a circumference, at 3 feet from the ground, of 6 feet 6 inches, and a height of from 60 to 70 feet. As a contrast an adjoining tree of the same age had a girth of only 20 inches and a height of about 50 feet. The method of tapping witnessed was that known as the "three-cut herring bone." Experiments conducted at Henaratgoda have proved that, taken year by year, as much latex is secured by the "three-cut herring bone" system as is the case when a much larger number of cuts is made.

The method of tapping known as the "full-spiral" and "half-spiral" are not in favour at Henaratgoda, though both have been given a good trial there.

The "three-cut herring bone" system is carried out as follows:—On fairly old trees the rough bark is lightly removed with a draw knife such as is used by carpenters, but on young trees this is not necessary. The circumference of the tree is then taken with a tape and the trunk divided into two equal parts to a height of about 5 feet from the ground. At each half section a perpendicular line is marked off with a piece of chalk, and on either side of this line three oblique lines are similarly marked off, a foot apart, connecting at their base of this line three oblique lines are similarly marked off, a foot apart, connecting at their base with the perpendicular line. To enable the oblique line to be accurately laid off, a triangular-

shaped implement of pliable hoop-iron is used, which much facilitates the work. The central line is first cut and then the oblique ones commencing from the top downwards.

A special marking knife is usually used for these lines though the ordinary tapping knife is employed by some.

Great care is taken not to expose the "Cambium Layer" which would result in serious injury to the tree. A tin spout is pressed into the bark at the base of the perpendicular cut, and a cup to hold the latex is placed on the ground or suspended from the tree under the tin spout.

A little ammonia is placed in the cup to prevent coagulation of the latex, and the tapping knives are also occasionally smeared with ammonia to keep them clean and workable. After the cuts have been made to the required depth a revolving "pricker" is pressed into the cambium for the whole length of the cuts, and immediately the latex ooses out and trickles down the sectional cuts into the perpendicular channel, and thence by means of the spout is conveyed to the cup.

Subsequent tapping operations consist of removing a thin slice of the bark sideways so as to expose a new surface, when by the use of the picker the latex is again induced to flow. Except during the dry months each tree is tapped daily. Usually eight to ten months are needed to complete the tapping of each half of the trees and then the other half is similarly treated.

Under judicious tapping new bark soon forms so that the surface originally tapped can be again dealt with.

Coagulation of Para Latex.—The latex is strained through pieces of muslin to remove impurities and then emptied into shallow enamelled trays. Three times as much water is added to the latex—water three parts, latex 1 part—and to the whole acetic acid is added and mixed together. At Henaratgoda it was understood that pure commercial acetic acid is diluted with water to 10 % of its original strength, and 33 c.c. of diluted acid is used to 100 c.c. of latex. Coagulation is completed in from 6 to 12 hours from the application of the acid, but by using a stronger solution the process is hastened.

Preparation of Para Rubber Biscuits.—After coagulation the plastic rubber, which has assumed the shape of the tray, is placed on a damp board or table and rolled out with an ordinary rolling pin, care being taken to keep the biscuit as round as possible.

About 200 c.c. of raw latex make one biscuit, and at Henaratgoda about eight of such biscuits go to the pound of dry rubber. After rolling, the wet biscuits are placed on cloth-covered slanting frames to partially dry under cover, after which drying is completed by hanging them on bamboo rods in the dry houses. The latex from the older trees is said to give clearer rubber than that from young trees.

Early morning is the best time for tapping, and one man can tap about sixty separate trees, from which $\frac{1}{2}$ to $\frac{3}{4}$ lb. of latex is obtained.

Para Rubber in East Africa.—Except in hot, wet, humid districts such as those adjoining the Ramisi, Mwachi and other rivers in the coast belt, there is little prospect of Para rubber succeeding in East Africa; and even in the districts named there is, as yet, no data to guide planters.

At Kusitawi on the Mwachi river a young plantation of Para rubber has been recently planted, but the growth of the trees is not as satisfactory as was hoped for.

(*To be continued.*)

A SQUARE DEAL FOR THE SOIL.

(From the *Louisiana Planter and Sugar Manufacturer*, Vol. XLII., No. 10, March 10, 1909.)

What is the biggest business problem this nation is facing to-day? One man will speak up quickly and say: "The question of an elastic currency, of course:" his neighbour will declare that the attitude of the administation toward corporations overtops everything else in importance to the people of this country. A little later we are likely to be told that the readjustment of the tariff is the overshadowing question.

But all the time a problem bigger than any of these is being overlooked by the politicians of all parties, by the press of the entire country, by the political economists and by most of the people themselves. Only a few men recognize the existence and the bigness of this question, and they are of the kind that make very little noise in the world. However, if they are not listened to and their words taken to heart by the men who make up the greatest industrial class in the United States, we, as a nation, will suddenly wake up to the fact that we have been committing industrial suicide.

The reckless and wholesale depletion of the fertility of the soil, in this good land of ours, is beyond all question the

biggest and the most serious question now confronting the American people—and it is bound to remain the big problem for many years to come. I am so sure of this, and feel so deeply on this matter, that I have determined to devote the remaining years of my life to doing all I can to arouse the farmers of this country to the fact that, if they go on taking everything they can out of the soil and putting next to nothing back, they are in the position of deliberately and knowingly creating a hopeless run on the greatest and richest bank in the world—the marvellous soil of the United States—a run which can result only in wreck and disaster as wide as the country.

This is the dark side of the picture, the thing which will surely happen if we do not wake up and give the soil a square deal. There is another side to the problem as bright as this one is dark—a reward for well doing just as great in proportion as the punishment for wrong-doing. If only twenty-five per cent. of the farmers of this country would wake up to the situation and do their level best in giving the soil a square deal, they would not only save the absolute loss of millions of dollars, but they would make millions more—and make themselves rich in the bargain. Unless there is a general and widespread reform in this matter of the mistreatment of our soil we are going literally to put millions of acres of good land out of business. All we have to do, to cut out of our national wealth land enough to make a dozen European kingdoms, is to keep right on doing what we are doing, and what we have been doing ever since the first reaper and binder was put into the field. In the matter of soil depletion the farmers of this country have been going the pace that kills—that kills land and robs the nation of a yearly power to produce a volume of wealth almost beyond the power of the average man to understand.

This problem is not a theory with me; I haven't come at it from the theoretical side. To the contrary. I have bumped against it from the practical, the active side. I did not leave the farm until I was twenty-six years old, and there hasn't been a year of my life since when I haven't been in some kind of business which was close to the soil. And for many years I have owned and operated several thousands of acres of farm land—and do so now. And I may add that I have not a single farm which I have not made to pay a good and satisfactory percentage on the investment year after year. I say this simply because the farmers do not take kindly to advice from mere theorists; they naturally wish to know that advice comes from a practical and successful farmer before they attach enough importance to it to act upon it. This is right and natural, and it is because I am so anxious to have them give to my plea the weight which it deserves that I say to them: I am entitled to talk about farming because I was brought up on a farm, and operated several thousand acres of farm land, divided into farms of 160 acres each, in a way which makes them pay me a handsome profit.

BUILDING UP THE LAND.

Right from the start I made up my mind to buy good farms and keep them and run them for profit. This meant that I looked at them as a long-time investment, not as something on which to speculate or make a quick turn. In other words, the task before me was that of building up and making the farms better each year, stronger in their ability to produce profitable crops. How many farmers treat their land in this way? Fewer, by far, than you would suppose! Of course, most of them intend to do this—but there is a wide gap between their intentions and their practice. It is no exaggeration to say that the majority of farmers in this country are living on their "principal" instead of their "interest," so far as their treatment of their soil is concerned: they are raising fair to excellent crops, putting up good buildings and making, perhaps, a fine showing on the profit side of the ledger, but in doing this they are literally bankrupting the soil—robbing it of the capacity to keep up the pace of production in the future.

In any state of the Union, from the richest to the poorest, the casual observer can see for himself how the soil is being bankrupted by heavy cropping and poor fertilization. There are large tracts in Virginia, for example, where farm after farm can be bought at an almost absurd price. Not very long ago these same acres were the pride of the Old Dominion state and produced fortunes to their owners in their unfailing tobacco crops. Now they are next door to useless as tillable land and about all their value is in the way of fine scenery. They have been depleted by taking from them the elements required to grow crops, while comparatively nothing has been put back into them to prevent bankruptcy. The same thing can be seen in Southern Illinois, where there are large districts which produce scant crops and where farms can be bought at one-third—even a fourth—of the price of good farm lands

in the middle and northern part of the state. Ordinarily these Southern Illinois farms were nearly, if not fully, as productive as any in the state. They have been under the give-nothing-and-take-everything system of cultivation, and the result is that the land has been put out of business because of mistreatment. And so you will find it in every state where the land has been worked on this plan for any considerable number of years.

But we are not left to size up in a general way the results of this suicidal method of land cultivation; the scientists who are working in the field of agriculture have produced some very exact information which tells the story in a pointed and a precise way. A careful reading of these authorities points to the fact that the grain crops are reducing the productiveness of the soil, under present methods of cultivation, at the rate of two per cent. a year. Few men in America have gone into the subject more deeply than Professor Hopkins, of the University of Illinois, and he does not hesitate to declare his conviction that, if we keep on farming as we are now doing it in Illinois, the State will be an unproductive desert within a century. He has not come to this conclusion by guess work, but by a most careful system of actual experiments.

On one piece of ground under his charge corn has been raised for twenty-eight consecutive years—raised according to methods common throughout the state. The productiveness of that piece has steadily declined, and it is certain that, in a very few years, it will not have enough power left to produce either corn or clover. Our grain farmers seem to feel that crop rotation consists in alternating corn and oats on their land. How does this work out? Professor Hopkins has put this to the test. The land on which he has tried this system was as good, originally, as any in Illinois, and yet it produces only thirty bushels of corn and thirty bushels of oats to the acre. Now what does the other side of this scientific work show? Practically alongside the strips of land on which these experiments have been conducted are strips not a whit better or richer, naturally. They have been handled on a different system of cultivation. The plots which have been subjected to true crop rotation—clover, corn and oats—and have been intelligently fertilized have produced ninety bushels to the acre. As showing what real crop rotation will do without the use of fertilizer I cite the fact that he gets sixty bushels to the acre on land planted to successive crops of clover, corn and oats. My own experience is that I can raise seventy-five bushels of corn to the acre on land subjected to right crop rotation and right fertilization as against thirty bushels per acre raised by my immediate neighbours working by the old methods on land naturally as good as my own. This I have done right along and on a large scale, too. What is more, my land under proper treatment is growing better year by year, while theirs is steadily going down in productiveness—and consequently in price. If they stick to their methods their land will, in a few years, reach a grade of unproductiveness at which it will not pay for cultivation.

As nearly as I can arrive at it, about seventy per cent. of the farm land in Illinois, for example, has been cultivated for thirty years under a "crop rotation" consisting of alternating corn and wheat, with almost nothing save the stubble put back into the soil. This is one important reason why Eastern States—Maine, New Hampshire, Connecticut and others—get a very much higher average yield of corn to the acre than the great corn states of the Middle West. In the East they practice crop rotation and intelligent fertilization.

Before leaving this question of how our soil is depleted, let me emphasize the fact that the United States—the newest and greatest of all agricultural countries—is admitted by soil scientists to stand first in the list in the rapidity of its soil exhaustion, and that we are rapidly adding to our area of abandoned agricultural lands.

And it may be well to add to what I have said of the experiments under Professor Hopkins a suggestion of what has been done in the same line of demonstration in England, where they have had more time in which to try out things. At the famous Rothamsted Station they have grown wheat on the same piece of ground for fifty years—with the result that "the phosphorus actually removed from one of the best yielding plots in fifty years is equivalent to forty per cent. of the total phosphorus originally contained in the soil to a depth of seven inches."

ROTHAMSTED EXPERIMENTS IN CONTINUOUS WHEAT FOR FIFTY-ONE YEARS.

	Average yield Bushels per acre.
No fertilizer	13·1
Farm manure—14 tons per acre... ...	35·7
Commercial fertilizer: Acid phosphate 392 lbs. per acre; Sulphate of potash 200 lbs. per acre...; Sulphate of ammonia 600 lbs. per acre	37·1

The manure used on an acre contained nearly double the plant food contained in the commerical fertilizer used on same-sized plant.

Again, it comes to a question of the use of fertilizer. Here are the figures from the famous experiments of Lawes and Gilbert :–

AVERAGE YIELD OF WHEAT PER ACRE.

	Bushels.
No manure for 40 years...	14
Minerals alone for 32 years	$15\frac{1}{4}$
Nitrogen alone for 32 years	$23\frac{1}{2}$
Farmyard manure for 32 years ...	$32\frac{3}{8}$
Minerals and nitrogen for 32 years ...	$36\frac{1}{4}$
Minerals and nitrogen for 32 years ...	$32\frac{3}{4}$

1·86 pounds of nitrogen as sodium nitrate.
2·86 pounds of nitrogen as ammonium salts.

Now, to get nearer home, let me tell the experience of a farmer in Northern Indiana who woke up to the fact that he must give his soil a square deal if he would get the same from it in return. He first found out what elements his soil most needed and then he fertilized accordingly. This cost him $1 to $1·40 an acre, and he kept close tab on the results. In a word, his fertilization cost has been thirty-five cents for the production of twenty bushels of corn, and he has had five hundred per cent. left for investment. This matter of treating the soil is much like a bank account. If you keep drawing out and put little or nothing in, time will sooner or later write "no funds" across the face of the draft which you attempt to make against it.

A farmer does not need to have an elaborate scientific education to understand the really necessary things about the elements which go into the making of a crop. The main ones are phosphorus, nitrogen and potash. Phosphorus is the element which makes things mature and go to seed—which makes the ears of corn and heads of wheat fill plump and ripe kernels. Nitrogen gives size to the plant and potash contributes the element of health or stamina. When your crop is yellow and does not grow to size it lacks nitrogen; when it grows rank and dark green and keeps on growing but doesn't mature and produce grain it lacks phosphorus; if, in addition, it is inclined to lodge and the stalk or straw is soft and lacks polish you know your land is short on potash.

Speaking roughly, a clay soil is generally deficient in nitogen and phosphorus, but contains potash. The tendency is for clay soil to bake and get hard, and the addition of a little lime is calculated to correct this. Then the addition of nitrogen, either in the form of plant legume—as clover, for instance—or in commercial phosphorus (or phosphate) will balance up the soil.

Black soils are commonly strong in nitrogen and short of phosphorus and potash and have a tendency to become sour. Drainage, together with a supply of the lacking elements and an addition of a little lime, is the remedy needed.

THE LIFE AND DEATH OF SEEDS.

(From the *Gardeners' Chronicle*, Vol. XLVI., No. 1, 177, July, 1909.)

To all who have to do with plants, either economically or scientifically, the longevity of seeds is a question of interest and significance. In the literature of the subject is recorded a long series of more or less credible accounts of natural cases in which great longevity is attributed to seeds, even up to thousands of years. Only within the last two years, however, have we obtained unimpeachable data upon this subject. Prof. Becquerel in Paris and Prof. Ewart in Melbourne have lately published germination tests made upon the old seeds stored in museums since known dates. Of seeds older than 25 years, about 10 per cent. of the spices gave positive results. The records are held by *Hovea linearis*, 105 years (Ewart), *Cassia bicapsularis*, 87 years old, and *Cytisus biflorus*, 84 years old (Becquerel). In each case two or three seeds germinated out of ten that were tested.

Both observers notice that the species of greatest longevity belong mostly to the *Leguminoseæ*, and have "hard seeds," that is seeds in which the testa is provided with a thick, continuous cuticle. Such seeds only admit water and swell up after they have been pricked or filed or stripped of their cuticle by strong sulphuric acid. The fact that seeds thus closely sealed up show the greatest longevity suggests that protection from some external influence is a factor in the preservation of viability.

Becquerel has established the further interesting point that not only are these "hard" integuments impervious to air, but that the dry seed-coat (testa) of an ordinary Pea or Bean is also quite airproof; he found that no air was sucked through the seed-coat even in two years by a vacuum; the mycropyle also is naturally hermetically sealed in some way and allows no air to pass. But if the air in contact with the testa is saturated with water vapour, then the testa slowly absorbs water and presently begins to allow air to pass by diffusion. As these phenomena hold with uncuticulised seed-coats it is concluded that

pure cellulose walls are impervious to air when completely dried.

These dry integuments are also quite impervious to other gases, and to ether, chloroform and alcohol; the germ in the seeds is thus hermetically sealed beyond the reach of poisons, and this explains why seeds are not killed when kept for months in ammonia, sulphuretted hydrogen, alcoholic corrosive sublimate and other noxious substances. Such results in the past have been held to prove that the dormant protoplasm of the seed was in some special resistant, insensitive condition. Now we know that the protoplasm of the germ is not reached unless the testa be perforated; if this be done, then the seeds never survive contact with such poisons.

A philosophical question of great significance for our conception of the nature of life underlies these enquiries into the longevity and vitality of seeds, namely, the question whether it is possible for vital changes to be absolutely arrested without death—irrevocable death—resulting.

Some observers have held that the resting seed is in a condition of retarded vital activity; others, that all vital activity is completely arrested. It is clear, even on the former view, that any vital changes in the seed are very slight and slow, so that experimentally it becomes very difficult to decide between these views: between no change and a just perceptible change. If it could be established that the living seed passes, on drying, into a state of complete rest, a state of "static equilibrium" as opposed to the dynamic equiliburium of the ever-changing living cell, then this important, fundamental question would be finally answered.

The resistance of resting seeds to extreme cold and to extreme desiccation supports the view that the protoplasm is here in a state of static equilibrium quite analogous with the condition of a charge of explosive before it is started into action by spark or blow.

Prof. Becquerel's work shows that it is impossible for a seed perfectly devoid of moisture to conduct the gaseous exchange involved in the process of respiration. Some observers have stated that resting dry seeds continuously produce carbon dioxide, while others have failed to confirm this. It now turns out to be chiefly a question of whether the seed contains enough of water for its integuments to be permeable to gases. In this connection it must be remembered that so-called dry seeds of commerce contain 5 to 15 per cent. of water, and that it takes months to dry off all this water from them It seems quite clear that if the seed is completely dried no detectable amount of respiration takes place within long periods of time.

As regards cold, all observers are agreed that the vitality of ordinary dry seeds is quite unaffected by exposure to the extreme cold of liquid hydrogen—250°C. It is generally held that all chemical change is in abeyance at such a temperature, and that, therefore, the seed cannot be in any other than a state of static equilibrium. This would seem to be true of such chemical changes as are essential parts of vitality, though, of course, a few violent chemical reactions do occur at this low temperature.

According to the modern conception of the relation between temperature and chemical change, with falling temperature every reaction will go slower and slower, but however low the temperature change will be only retarded, not absolutely stopped. The resistance to cold cannot, therefore, finally settle this question.

We are, indeed, forced to conclude that the resistance of dry seeds to temperatures as high as 100°C. or even 120°C. favours the view of static equilibrium. If the protoplasm of resting seeds is entirely at rest in static equilibrium, then the viability of the seeds should endure indefinitely, like the explosibility of a properly stored charge of powder. It is, however, notorious that in a sample of stored seeds the percentage of germination steadily decreases. To what can we attribute this loss of viability? It is suggested that just as the proper working of a charge of powder may be destroyed by accidents of storage such as dampness, so in the case of stored seeds the falling off is due to changes wrought in them by oxidation or hydration.

Seeds are very hygroscopic and absorb water in direct proportion to the humidity of the air. Jodin has recorded the varying weight of seeds in different meteorological conditions, and one of the few, changing factors in an ordinary resting seed stored in air must be this alternate taking up and giving off of water. Possibly the ceaseless, slight molecular changes involved in this process slowly disorganise the viable protoplasm and in time cause the death of the seed. From such changes a "hard" seed would be exempt. It is therefore probable that complete desiccation and preservation in a dry environment are necessary conditions for testing the maximum longevity for any plant whose seeds are among the majority in which the testa is not impermeable to water.

Another change that goes on slowly but progressively is oxidation, oxidation of a purely chemical, non-vital character. Such chemical oxidation of the substances in the cells of the resting embryo might, in time, destroy the organisation needed to maintain viability, even if the organisation were, as regards vital changes, in a state of static equilibrium all along. If there is this risk, analogous to the rusting of machinery, then critical experiments upon the longevity of seeds must be carried out in the absence of oxygen as well as of moisture.

That stored seeds should in time die seems to us a natural thing, but it must not be forgotten that the death of seeds is biologically on quite a different plant from the death of individual plants. The natural death of the bodies of plants is an advantageous condition for the race that arose in the course of evolution and has become fixed. The death of seeds is not natural in this sense, not the outcome of internal processes, but it is accidental in the strict sense, brought on from without.

In order to test the longevity of seeds under conditions which prevent either of these slow changes, Prof. Becquerel has carefully dried seeds (by keeping them, after perforating the testa, at 45°C. in contact with strong desiccating agents for months), and has then sealed them up in glass bulbs in perfect vacua. These experimental seeds have been formally deposited with the Bureau of Standards in Paris, and their vitality is to be tested every ten years. Should they show no mortality, it is suggested that in this way standard plants may be handed down to remote posterity for comparison with the forms that evolution has produced in many generations of descendants. Only by such organised experiments as these, planned to endure beyond the life of an individual invesigator, can these important questions be finally solved.

Correspondence,

PAPER PULP FROM BAMBOOS.

21-35, NAKAMURA,
YOKOHAMA, July 21, 1909.

DEAR SIR,—I am interested in the article by Mr. Wm. Raitt on bamboo pulp, which appeared in a recent number of your Magazine. The suggestion is no doubt quite practicable, and the industry should be fostered by all means where supply of the material is plentiful. Mr. Wm. Raitt will be interested to know what is being done in the very same line in Formosa. If has been reported in the press that Mitsubishi Co. have started a paper mill there with investment of a million Yen. Bamboo forests will be utilized as the source of material and paper will be placed on the market before long. The bamboo paper industry of hand-making process has been conducted in the Island to the extent of Yen 200,000 annually, according to the report of American Consul Mr. James W. Davison in 1902. The present undertaking is nothing more than a shifting from hand process to machinery on a larger scale. A similar project is under contemplation in sub-tropical region of America where bamboos rank beyond human control.—Yours faithfully,

S. IIDA.

[*Note.*—Japan is peculiarly interested in this question, as at present she imports the bulk of her paper-making material from Europe. The development of the effort, reported by our correspondent, to produce this material within her own territory, will therefore be watched with keen and sympathetic interest. It has also been announced recently that a French Company intends making a similar effort in French Indo-China. Hand-made paper from bamboo is a very ancient industry, not only in Formosa but also in Siam and Burma. It is scarcely a paper in the modern use of the term—rather a tablet or slate,—but its successful manufacture and use, like all paper, depends on the fibrous (cellulose) contents of the raw material.—W. RAITT.]

MARKET RATES FOR TROPICAL PRODUCTS.

(From Lewis & Peat's Monthly Prices Current, London, 15th September, 1909.)

	QUALITY.	QUOTATIONS.
ALOES, Socotrine cwt.	Fair to fine ...	85s a 90s
Zanzibar & Hepatic ,,	Common to good ..	40s a 70s
ARROWROOT (Natal) lb.	Fair to fine ..	2⅞d a 4d
BEES' WAX, cwt.		
Zanzibar Yellow ,,	Slightly drossy to fair ...	£6 7s 6d a £6 10s
Bombay bleached ,,	Fair to good	£7 10s a £7 12s 6d
,, unbleached ,,	Dark to good genuine ..	£5 10s a £6 5s
Madagascar ,,	Dark to good palish	£6 7s 6d a £6 12/6
CAMPHOR, Japan ,,	Refined	1s 5¾d a 1s 6d
China ,,	Fair average quality ...	135s
CARDAMOMS, Tuticorin	Good to fine bold	1s 10d a 2s 2d
	Middling lean	1s 6d a 1s 8d
Tellicherry	Good to fine bold ..	1s 9d a 2s
	Brownish ..	1s 3d a 1s 7d
Mangalore ,,	Med brown to fair bold	1s 10d a 2s 8d
Ceylon, Mysore ,,	Small fair to fine plump	1s [illegible]d a 2s 11d
Malabar .	Fair to good ...	1s 4d a 1s 6d
Seeds, E. I. & Ceylon ,,	Fair to good ..	1s 7d
Ceylon Long Wild ,,	Shelly to good ..	6d a 1s 6d nom.
CASTOR OIL, Calcutta ,,	Good 2nds ..	2d
CHILLIES, Zanzibar cwt.	Dull to fine bright ...	35s a 40s
CINCHONA BARK.— lb.		
Ceylon	Crown, Renewed	3⅜d a 7d
	Org. Stem	2d a 6d
	Red Org. Stem	1¾d a 4¼d
	Renewed	3d a 5¼d
	Root	1⅜d a 4d
CINNAMON, Ceylon 1sts	Good to fine quill	10d a 1s 4d
per lb. 2nds	,, ,,	9d a 1s 2d
3rds	,, ,,	7½d a 11½d
4ths	,, ,,	6½d a 9½d
Chips, &c..	Fair to fine bold	2⅝d a 3⅛d
CLOVES, Penang lb.	Dull to fine bright pkd.	1s a 1s 3d
Amboyna ..	Dull to fine	8d a 8 d
Ceylon ..	,, ,,	7½d a [illegible]d
Zanzibar	Fair and fine bright	4⅝d a 4¾d
Stems ..	Fair	1½d
COFFEE		
Ceylon Plantation cwt.	Medium to Bold	nominal
Native	Good ordinary	nominal
Liberian ,,	Fair to bold	43s a 55s
COCOA, Ceylon Plant. ,,	Special Marks	60s a 74s
	Red to good	54s a 59s
Native Estate ,,	Ordinary to red	38s a 54s 6d
Java and Celebes ,,	Small to good red	30s a 85s
COLOMBO ROOT ,,	Middling to good	15s a 17s 6d
CROTON SEEDS, sift. cwt.	Dull to fair	30s a 35s
CUBEBS ,, ,,	Ord. stalky to good	80s a 90s
GINGER, Bengal, rough ,,	Fair	30s
Calicut, Cut A ,,	Small to fine bold	60s a 85s
B & C ,,	Small and medium	52s a 60s
Cochin Rough ,,	Common to fine bold	38s a 42s
	Small and D's	37s 6d
Japan ,,	Unsplit	36s
GUM AMMONIACUM ,,	Sm. blocky to fair clean	25s a 60s nom.
ANIMI, Zanzibar	Pale and amber, str. srts.	£16 a £18
	,, ,, little red	£13 a £15
	Bean and Pea size ditto	75s a £12
	Fair to good red sorts	£9 a £13 10s
	Med. & bold glassy sorts	£7 a £9 5s
Madagascar ,,	Fair to good palish ...	£4 a £8 15s
	,, ,, red ...	£4 a £7 10s
ARABIC E. I. & Aden ,,	Ordinary to good pale	25s a 32s 6d nom.
Turkey sorts ,,		27s 6d a 47s 6d
Ghatti ,,	Sorts to fine pale ...	20s a 42s 6d nom.
Kurrachee ,,	Reddish to good pale ...	20s a 30s ,,
Madras ,,	Dark to fine pale ...	15s a 25s ,,
ASSAFŒTIDA ,,	Clean fr. to gd. almonds	120s a 140s ,,
	com. stony to good block	15s a 100s ,,
KINO	Fair to fine bright	6d a 9d
MYRRH, picked cwt	Fair to fine pale	80s a 115s
Aden sorts ,,	Middling to good	55s a 70s
OLIBANUM, drop ,,	Good to fine white	40s a 60s
	Middling to fair	25s a 35s
pickings ,,	Low to good pale	6s 6d a 17s 6d
siftings ,,	Slightly foul to fine	13s a 15s
INDIA RUBBER lb.	Fine Para bis. & sheets	7s 4d
	,, Ceara ,, ,,	7s 4d
Ceylon, Straits, Malay Straits, etc.	Crepe ordinary to fine..	6s 6d a 7s 6d
	Fine Block ..	8s
	[illegible] to fine ..	5s 1d a 5s 3d
Assam	Plantation	4s 10d a 5s [illegible]d
	Fair II to ord. red No. 1	4s a 4s 8d
Rangoon	,, ,,	3s 2d a 4s 2d

	QUALITY.	QUOTATIONS
INDIARUBBER (*Contd.*)		
Borneo	Common to good	1s 6d a 2s 8d
Java	Good to fine red ..	2s 6d a 4s 4d
Penang	Low white to prime red	2s a 3s 3d
Mozambique	Fair to fine red Ball ...	3s 8d a 5s [illegible]d
	Sausage, fair to good ..	3s 6d a 5s
Nyassaland	Fair to fine ball ..	3s 8d a 4s 8d
Madagascar	Fr to fine pinky & white	2s 10d a 3s 8d
	Majunga & blk coated ..	2s 3d a 2s 9d
	Niggers, low to good .	1s 6d a [illegible]s 2d
New Guinea	Ordinary to fine ball ..	3s 2d a 4s 6d nom
INDIGO, E.I. Bengal	Shipping mid to gd violet	2s 10d a 3s 8d
	Consuming mid. to gd.	2s 6d a 2s 10d
	Ordinary to middling	2s 2d a 2s 5d
	Oudes Middling to fine	2s 6d a 2/8 nom.
	Mid. to good Kurpah	2s 2d a 2s 6d
	Low to ordinary	1s 6d a 2s
	Mid. to fine Madras	1s 5d a 2s 4d
MACE, Bombay & Penang per lb.	Pale reddish to fine	1s 11d a 2s 4d
	Ordinary to fair	1s 8d a 1s 10d
Java	,, ,, good pale	1s 7d a 2s 1d
Bombay	Wild	4d a 5d
MYRABOLANES, cwt	UG and Coconada	5s a 5s 6d
Bombay ,,	Jubblepore	4s 9d a 6s 9d
	Bhimlies	4s 9d a 7s
	Rhajpore, &c.	4s 6d a 6s 3d
Bengal ,,	Calcutta	5s a 5s 6d
NUTMEGS— lb.	64's to 57's	[illegible]s 3d a 1s 6d
Bombay & Penang ,,	110's to 65's	4¾d a 1s 2d
	160's to 115's	4d a 4½d
NUTS, ARECA cwt.	Ordinary to fair fresh	14s a 16s
NUX VOMICA, Cochin per cwt.	Ordinary to good	9s a 11s 6d
Bengal	,, ,,	6s a 6s 6d
Madras	,, ,,	6s 3d a 8s
OIL OF ANISEED ,,	Fair merchantable	4s 5d
CASSIA ,,	According to analysis	3s 8d a 4s
LEMONGRASS ,,	Good flavour & colour	2d a 2¼d
NUTMEG ,,	Dingy to white	1½d a 1¾d
CINNAMON ,,	Ordinary to fair sweet	2¼d a 1s
CITRONELLE ,,	Bright & good flavour	1s 0½d a 1s 1½d
ORCHELLA WEED—cwt		
Ceylon ,,	Mid. to fine not woody...	9s a 11s
Madagascar ,,	Fair ...	9s
PEPPER— (Black) lb.		
Alleppee & Tellicherry	Fair ...	3⅝d
Ceylon	,, to fine bold heavy ..	3¼d a 3½d
Singapore ...	,, ...	3¼d
Acheen & W. C. Penang	Dull to fine	3⅛d a 3½d
(White) Singapore ,,	Fair to fine	5⅛d a 8d
Siam ,,	Fair	5¼d
Penang ,,	Fair	5d
PLUMBAGO, lump cwt.	Fair to fine bright bold	—
	Middling to good small	—
chips	Dull to fine bright ..	—
dust	Ordinary to fine bright	—
SAGO, Pearl, large ...	Dull to fine .. .	15s a 16s 6d
medium ..	,, ,,	14s a 15s
small ...	,, ,,	12s a 13s 6d
SEEDLAC cwt.	Ordinary to gd. soluble	50s a 65s
SENNA, Tinnevelly lb	Good to fine bold green	5d a 7d
	Fair greenish	3½d a 4½d
	Common specky and small	1½d a 2¾d
SHELLS, M. o'PEARL—		
Egyptian cwt.	Small to bold ..	35s a 115s nom.
Bombay ,,	,, ..	21s a 115s
Mergui ,,	,, ,, ...	£[illegible] a £8 15s
Manilla ,,	Fair to good ..	£5 12/6 a £10 10s
Banda ,,	Sorts	25s a 30s nom.
TAMARINDS, Calcutta.. per cwt.	Mid. to fine bl'k not stony	11s a 13s
Madras	Stony and inferior ..	4s a 5s
TORTOISESHELL—		
Zanzibar, & Bombay lb.	Small to bold ..	8s a 31s
	Pickings ..	3s a 18s 6d
TURMERIC, Bengal cwt.	Fair .	18s
Madras ,,	Finger fair to fine bold [bright	17s a 18s
Do. ,,	Bulbs	14s a 15s
Cochin ,,	Finger .	15s
	Bulbs ..	13s 6d
VANILLOES— lb.		
Mauritius .. } 1sts	Gd crystallized 3½ a 8½ in	9s a 16s
Madagascar ... } 2nds	Foxy & reddish 3½ a ,,	8s 3d a 12s
Seychelles .. } 3rds	Lean and inferior ...	8s 3d a 8s 9d
VERMILLION ..	Fine, pure, bright .	2s 10d
WAX, Japan, squares	Good white hard ...	45s

THE SUPPLEMENT TO THE

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RUBBER OUTPUT ESTIMATES.

UP TO 1913: A MALAYA VIEW.

In the present rubber boom time, when practically every day a new flotation is announced, the thoughts of the cautious naturally turn to the possibility of over-production. It may be interesting, therefore, and instructive to collect the data at our disposal and to estimate what the output of plantation rubber may reasonably be expected to be during the next few years—say, up to 1913, the year in which all the trees planted up to the end of 1908 will be tappable. For the purposes of this enquiry, from which, of course, only approximate conclusions can be drawn, it will be necessary to assume that conditions in the rubber producing countries, such as the number of trees to the acre, the growth of the trees, freedom from pest, and the amount and quality of rubber obtainable at a given age, are identical. The countries to be taken seriously into consideration are, in addition to the F.M.S. and S.S., Ceylon, Java, Sumatra and Borneo. From the annual report we find the planted acreage in the F.M.S. at the end of last year was 168,000, and in the S. S. 73,000. The two Ceylon papers—the "Times" and the *Observer*—are substantially in agreement as to the acreage under rubber in Ceylon, which they estimate roughly at 180,000 acres. Java and Sumatra possess about 40,000 acres planted and Borneo about 10,000. So that we have

	acres.
F.M.S. and SS.	240,000
Ceylon	180,000
Java and Sumatra	40,000
Borneo	10,000
Total	470,000

Now it is held by those whose opinion carries weight that an acreage tapped in one year will yield about one-fifth more in the next. To estimate, therefore, a year's crop, it is necessary to take the previous year's crop, plus 20 per cent., and add the estimated crop from the new acreage which comes into bearing. A glance at the statistics given in the Director of Agriculture's report of the acreage planted and the number of trees shows that the average is, roughly, 150 trees to the acre. During last year the average yield per tapped tree all over this Peninsula was 1 lb. 15¾ ozs. To be on the safe side, we may estimate the yield at 1½ lb. per tree, which gives a yield per acre of 225 lb, and, allowing for wastage, we arrive at a minimum yield per acre of 200 lb. Now the F.M.S. in 1908 exported 3,155,600 lb, or 1,413 tons. Eight thousand acres, planted in 1904, come into bearing this year, so that, adding 20 per cent. to last year's total, and estimating the output of the new average at 8,000 × 200, we arrive at an estimate of 5,398,720 lb, or 2,400 tons, for this year. The export has already reached 3,000,000 lb, so it fairly certain that the estimate is a conservative one. In 1910 24,000 more acres come into bearing, and by the same method the total output will exceed 11,000,000 lb, or, say 5,000 tons. In 1911 the acreage is increased by 42,000, and our estimate places the output at nearly 22,000,000 lb, or 9,600 tons. Forty thousand acres more come in in 1912, and the estimated output is 34,000,000 lb, or 15,000 tons. Finally

IN 1913

the whole of the area planted at the end of 1908 will be in bearing and the estimate is just on 50,000,000 lb of rubber, or

22,000 TONS.

By taking the number of trees planted at the end of 1908—26,000,000—and estimating 2 lb. yield from each tree, less wastage, we arrive at much the same total. Now if we assume for the sake of argumont that the other producing countries are doing exactly what we are doing, a computation of the total output from all the countries named, possessing a total acreage of 470,000, is merely a question of arithmetic, and works out at about

61,500 TONS OF PLANTATION RUBBER.

The world's annual consumption stands now at about 70,000 tons. Now our estimates of probable outputs have been very conservative, and we have taken no account of additional acreage which might be tappable in 1913, but it is clearly very improbable that the total output of plantation rubber in 1913 will do more than equal the present world's consumption of rubber. That consumption, in the natural course of events, may be expected to increase by 1913, and then, of course, there is the question of the price. No one in his senses supposes that the present price of rubber will be maintained for ever. We have seen various estimates of the probable average prices of rubber during the next few years, in technical journals, in prospectuses and elsewhere. We think we are perfectly safe in estimating that the average price for plantation in 1913 will not be less than three shillings, or two shillings per pound profit on a well-managed estate. At three shillings per lb. any number of new uses for rubber would be found practicable, and experts are agreed that a heavy drop in price would be followed by a largely increased consumption. We have, of course, only dealt with the question generally, and all estimates must necessarily be somewhat vague, but we think we have produced enough facts to show that the question of over-production is not one which need be considered for some years to come.—*Malay Mail*, Aug. 25.

A NEW PROCESS FOR PRODUCING PURE RUBBER.

A London chemist, Mr O Aubrey Elias, F.C.S., of 123, Waller Street, New Cross, claims to have discovered a new process for producing pure rubber. He has given to a Press Association representative some interesting particulars concerning his discovery, which, he says,

WILL REVOLUTIONISE THE METHOD OF RUBBER PRODUCTION.

His invention relates to a new process for instantaneously coagulating Para rubber latex, while it incidentally retards fermentative changes, which are attributed to the presence of sugars, proteids and other impurities that are by this method apparently removed or rendered inert in the finished product. The process produces a superfine rubber and tends to convert all "Para fine" latex into a uniform standard and staple quality. This method utilises all the latex, and abstracts a considerable portion of moisture from the caoutchouc, thus greatly faciliting the process of drying. The mother liquid is left quite clear and transparent, and may be used again with advantage for coagulating a further supply of the rubber milk. A single grain of this substance, if used in the pure or concentrated form, will almost instantaneously coagulate several hundred times its own weight of Para rubber milk.

Mr Elias explained that several rubber producing countries, such as Amazona and Ceylon, have recently devoted a great deal of attention to obtaining rubber in the pure form. The difficulty in this respect is due to the fact that coagulation of the milk or latex from the trees takes place slowly and the rubber retains a certain amount of albuminous matter and other impurities. This proteid matter is responsible for the development of micro-organisms, causing "tackiness" or "heating" of the raw rubber. Fresh latex contains from 1·9 to 2·7 per cent of albuminous matter, or approximately 3 to 4 per cent of the dried coagulated product. The undesirable conditions have been overcome by the new method, which is inexpensive and economical, saving much time and labour by doing in a few minutes what hitherto took about 24 hours to accomplish satisfactorily.

IMMEDIATE COAGULATION OF THE RUBBER CAN NOW BE EFFECTED,

and the coagulum may be at once pressed free from moisture, and dried without further treatment. The caoutchouc, he states, does not undergo any deterioration, and the quality is much improved both in appearance and elasticity, elements of considerable importance to the factors when selecting the raw material in the market for manufacturing into articles which are now almost indispensable to mankind.

At present the rubber is produced mainly by two methods, by drying the milk in thin layers in the presence of the antiseptic vapour of burning palm, or by the use of acetic acid. Both processes are faulty. In the case of the first, rubber, which is obviously dark in appearance, is obtained, while in addition the operation, which is tedious, is exceedingly detrimental to the health of the native producers, about 3 per cent of whom die from phthisis or other diseases which are the result of the conditions under which they labour. In regard to the second process, the fact that the amount of pure acetic acid necessary for the coagulation is so difficult to gauge forms a most serious drawback, apart altogether from the troubles which often arise in connection with the transit and use of the acid. Mr Elias declares the new method

HAS NONE OF THE DRAWBACKS OF THE OLD PROCESSES,

although it will not be more costly. The rubber produced is better, and consequently fetches a higher figure. The market price of best Para rubber ranges from 7s 6d to 8s per lb., and rubber produced by the new process has realised 4d per lb. more. Analyses of two samples show that they contained no proteids, and the analyst, in his report states: "These rubbers should have a high market value, particularly as they contain no undesirable albuminous matter, and are not likely to decompose or become 'tacky.'" The fact that decomposition will not set in is due to the absence of proteid matter, rubber produced under the new method thus being superior to that obtained under the old in this respect, and also because any analine colour can be added to the milk. Consequently, it is not surprising that 15 per cent more should be offered for rubber produced by means of the new method. Questioned as to the general effect of this invention, Mr. Elias remarked that it would revolutionise the process of rubber production, and he expressed the opinion that in course of

time his system would be universally adopted. By means of it, he claimed, translucent and extremely elastic rubber of a light amber colour is produced. In this form it is much more suitable for practical purposes than the rubber at present obtained. There is nothing objectionable in the new process, it is quite as cheap as the old ones, and the rubber produced is much superior, while the buyer will be able to ascertain easily the actual amount of caoutchouc to which he is entitled.—*H. & C. Mail*, Aug. 20.

RUBBER IN GERMAN NEW GUINEA.

The prospects of the production of rubber and guttapercha in German New Guinea are discussed in the "Frankfurter Zeitung" by a correspondent, who states that the question as to whether success will be met concerns all interests, and that this depends upon whether in course of time the millions of marks expended for this purpose will yield the hoped-for results, or whether they are to be considered as lost capital. During the past six or seven years the planting of rubber trees in New Guinea has proceeded on a large scale, and there are at present about 500,000 trees, covering a surface of approximately 3,000 acres. The progress of the plants has hitherto shown that the climate promises well for the trees which include Castilloa elastica, Ficus elastica and Hevea brasiliensis. A large number have not yet reached the age for tapping, although about three tons were harvested on the Stephansort plantation alone in 1908, and the result of the tests is awaited before proceeding with further extension of the plantations. The quality of the rubber has hitherto been regarded favourably. It is suggested that a testing institution such as exists in the Cameroons and German East Africa should be established in New Guinea. The cultivation of gutta-percha in New Guinea has so far not been undertaken on a noteworthy scale, but the existence of wild-growing plants has been determined by Dr. R Schlecter, although it is improbable that they are of much importance, as the trees are often situated miles apart. As most of the trees are in the mountainous districts it would scarcely be possible to induce the natives to win and deal with the product, and the work under European supervision would not be remunerative.—*India-Rubber Journal*, Aug. 23.

ASSAM RUBBER.

The rubber of *Ficus elastica* is known to vary in composition according to the age of the trees from which it is collected: young trees affording rubber with 20 to 30 per cent of resin and older trees affording rubber with less than 10 per cent. The comparatively large amount of resin in Assam rubber depreciates it in the market, and any means of improving the product, whether in collecting it only from mature trees or special treatment of the latex, would be welcomed by the trade. An interesting series of rubbers from *Ficus elastica* collected in Assam and adjacent provinces has been presented to the Museum by Mr. A T Wernigg. These being representative samples from different districts and from trees of different ages, their analyses are important. The first three samples were from the Government Plantation at Charduar, from trees 33 years of age, the fourth was from the Lushai Hills from trees of 70 years of age, the sixth was from the Mishmi Hills from old trees of 100 to 150 years of age:—

	Water	Caoutchouc	Resins	Proteids	Ash.
Charduar	0·5	83 0	15·1	1·0	·4
,,	1·4	87·1	11·5	1·2	·8
,,	2.8	80·4	13·4	1·4	2·0
Lushai	·4	89·1	8·8	·7	1·0
Bhutan	1·0	83·1	14·2	·7	1·0
Mishmi	1·3	79·4	16·6	1·2	1·5
Average	1·2	83-4	13·3	1·0	1·1

Tho average analysis of the above six samples may therefore be taken as typical of commercial Assam rubber. The crude rubbers would suffer a slight loss of woody particles in washing, and making allowance for this, the Caoutchouc content may be taken as not less than 80 per cent. Other samples of rubber are brought into Assam from neighbouring districts. These are collected in the forest by Native agency, and it was presumed that they are from *Ficus elastica*, but their composition is so good that probably they are derived from some other botanical source. One sample frm Bhutan and two from the Akha Hills were examined, and they were found to yield 90·9, 89·9 and 92·8 per cent. of caoutchouc and 4·9, 6·5 and 4·9 per cent. of resins. Such samples as these are of great value, and it would be an advantage if their supply could be carefully controlled.—Mr. D. Hooper, F.C.S., in *Calcutta Museum Report*, 1908 9, Industrial Section.

PALO AMARILLO RUBBER.

A Poor Latex Producer.

The Palo Amarillo tree was discovered a few years ago on the slopes of the Sierra Madre, and upon investigation it was found to be a botanically unknown species. It is known in Mexico under a number of common names, such as palo amarillo, palo colorado, papeillo and cucuracho, the first mentioned name being generally used. It occurs in the dry semi-tropic zone on the slopes of Sierra Madre, at an elevation of 900 to 4,800 feet generally being found above the oak zone, and frequently reaching as high as the pine zone of the mountains. It extends southwards from Durango to the southern part of Oaxaca, along tho Pacific coast, growing on rather poor, rocky or sandy volcanic soil, and it often forms a part of the xerophytic plant formations that have established themselves on the dry mountain sides. Tho tree grows to a height of between 20 and 34 feet, with a trunk diameter of from 7 to 12 inches. In the inner bark of the stem and its branches occur numerous latex-bearing vessels, containg a semi-liquid fluid of milky whiteness, which solidifies on contact with the air. Chemical examination of this latex shows that it

CONTAINS FROM 7·3 TO 15·7 PER CENT OF RUBBER,

and from 19 per cent upwards of resins. The United States Consul at the city of Mexico

says that he has personally analysed seventeen latex samples from different parts of the tree, and from trees growing in different soils. The latex from the lower parts of the trunk contains the higher percentage of rubber, as is the case with all rubber-producing trees. The branches carry a latex containing mainly resins, the rubber being about 3 to 6 per cent, and occurring in a form which makes it very difficult to be separated from impurities. The coagulation of the latex is not easy, although it can be accomplished. The resulting rubber is of inferior quality and would commercially be classed with Guayule rubber, which, it is stated, has commended a price of about one shilling and three-pence, where the price of first-class wild para rubber was three shillings and ninepence per pound during the last year when rubber prices were low. It may be noted that rubber made according to modern methods from the ordinary Mexican rubber tree—*Castilla elastica*—has reached the highest standard of Para rubber and has realised the same price. The product of the palo amarillo tree being new,

THE TEST OF TIME,

which after all is the most important one, has not yet been applied; but taking into consideration the low tensile strength, the large percentage of resins, and the rapid deterioration of the latex through enzymes, it is not very likely that palo amarillo rubber will show a better result than the rubber obtained from the guayule shrub. The rubber is easy to vulcanise by the ordinary methods. The exploitation of the latex of palo amarillo is beset with considerable difficulties. The Consul states that he has tapped these trees in all the different manners generally employed in tapping Hevea, Manihot, Castilla, Funtumia, Ficus, or Sapium trees, and he has used over twenty of the different tools and implements, patented and employed in the rubber fields in Brazil, Central America and Africa, and he says that

THE PROPER METHOD OF TAPPING,

palo amarillo is not easy to determine. It is claimed that the palo amarillo tree is very easily propagated. A young branch cut from a growing tree and planted in the ground will grow. Commercially this does not mean much as the exploitable age of a palo amarillo tree must be at least ten or eleven years. A tree of this age does not give a very large amount of latex. The ordinary Mexican rubber tree, *Castilla elastica*, can be exploited when eight years old, and it then gives a larger yield of latex per annum than a ten-year old palo amarillo tree. Considering that the latex of the former contains from 25 to 47 per cent of pure rubber, against about eight per cent in the palo amarillo latex, it is difficult to see the advantages of the latter under cultivation.—*Society of Arts Journal*, August 27.

RUBBER ACREAGE FOR GERMAN COLONIES.

AND CACAO CONSUMPTION IN GERMANY.

We are much indebted to Herr Ludwig W. Weddige, of Wattegodde, Matale, for the official data he gives us regarding the acreage of cultivated rubber in the German Colonies for 1909. The total in rubber in German Colonies, 18,525 acres, is certainly rather higher than we estimated—as also is the consumption of Cacao in Germany (nearly double—if our correspondent be correct.) We would like to know how much of the rubber is in bearing.

Watagodde, Matale, Aug. 31st.

DEAR SIR,—I take the liberty to give you below some data regarding the acreage of cultivated rubber in the German Colonies for 1909, which may be of use for you for your next year's Directory.

I find in this year's edition p. xxxix, footnote 2, the acreage under rubber in German East Africa given as 1,500 acres and the total New Guinea, New Caledonia, etc., as 3,000 acres.

The German Colonial Committee, the best authority on this subject, states the acreage under rubber for 1909 as follows :—

German East Africa (1)	...	7,410 acres.
Togo and Cameroons (2)	...	4,940 ,,
New Guinea (3)	...	3,705 ,,
Samoa (3)	...	2,470 ,,
Total German Colonies	...	18,525 ,,

(1) Mostly Ceara, lately Maniçoba and in some places Hevea.

(2) *Togo* : Ceara and Maniçoba. *Cameroons* : Ficus, Castilloa, but lately Hevea has been planted on a big scale.

(3) Mostly Hevea.

I find further you state the consumption of cacao (p. xl.) for Germany and North Europe together as 340,000 cwt.

According to official statistics the consumption of cacao in Germany was over 35,000,000 kg. = 77,161,000 lb. = 676,800 cwt. in 1906, and is without doubt greater today, the annual average increase being 2,400,000 lb.—I am, yours faithfully,

LUDWIG W. WEDDIGE.

ON THE AROMA OF BLACK TEA.

BY T. KATAYAMA,

It is of great importance for the manufacture of black tea, to know by what agencies its agreeable aroma is produced. The so-called fermentation of tea is attributed by some authors to microbes; by others, however, to the enzymes of the leaves. Bamber(*a*) denies the existence of a genuine fermentation, having been unable to observe any microbe. Newton(*b*) supposes that the flavour of black tea is dependent upon the action of an oxidizing enzyme in the tea leaf but Crole(*c*) and other authors ascribe the fermentation at least partly to the action of certain micro-organisms (*d*.)

(*a*.) Agricultural and chemistry of tea. (*b*.) On tea, a publication from India. (*c*.) Tea, its cultivation and manufacture. (*d*.) Aso has observed that the black colour of tea is caused by the action of the oxidase of the leaves upon the tannin present (Bul. College of Agriculture, Tokyo Imp. Univ., Vol. IV., No. 4.)

Since I had observed frequently bacilli on the rolled tea leaves undergoing the fermenting process, I was led to suppose that some relations between these bacilli and chemical changes in the tea leaf might exist. Hence I tried to kill the ordinary microbes adhering to the leaves and to infect the leaves with bacilli taken from *fermenting* leaves.

Fresh tea leaves were left in either for 4 hours, rolled and dried as usual. The green colour of these leaves not only gradually changed to brownish but also the characteristic aroma of black tea was observed after 10 hours, in spite of the odour of adhering traces of ether.

This experiment shows that the aroma is not caused by any micro-organisms. The same result was obtained when the ether was substituted by alcohol and chloroform. Also powerful antiseptics as cresol, mercuric chloride were tried. Fresh tea leaves were soaked in a 4 per cent cresol solution for 24 hours washed once with distilled water, dried in the sun and then rolled and kept compactly in a flask. The tea leaves changed gradually in colour to brownish black and after 15 hours produced a distinct aroma, modified however by the odour of traces of cresol remaining. Fresh tea leaves were left in a 1 per cent HgCl(*a*) solution for 20 hours, whereby the leaves assumed a pale appearance, and washed with distilled water. When kept in a flask, the characteristic aroma of black tea was also here observed after some time, but the blackening of the leaves was here not observed. When the so-called fermentation process is allowed to go on for too long a time before drying or firing, the normal aroma produced gradually disappears and a sour smell developes. Finally white mould appears on the leaves. However, if the leaf is treated with antiseptics as above-mentioned, the sour smell is not observed. These tests render it very probable that the development of aroma is due to the action of certain enzymes originally present in the leaves which produce the specific volatile oil of tea from certain compounds. This is in analogy to the flavour of tobacco which is also produced by the action of enzymes (oxidases).

I have further observed that after treating tea leaves with cyanogen gas for 5 hours the aroma fails to appear. When tea leaves are repeatedly treated with ether or alcohol, the aroma fails to develop which shows that those substances which yield the aroma have been extracted by ether and alcohol, which agrees with observations of Kozai(*b*.) Since Kozai, Bamber and other authors observed that black tea cannot be manufactured from steamed tea leaves, I have tried the influence of various lower temperature. The tea leaves were kept at these temperatures for an hour and after having gone through the usual process the results were as follows :—

40° C	.	good aroma	
50 ,,	..	do	
60 ,,	..	only a very weak aroma	
65 ,,	..	no aroma, only a raw	grassy smell
75 ,,	..	do	do
100 ,,	..	do	do

(*a*.) On tea, a publication from India. (*b*.) Bulletin College of Agriculture, Tokyo Imp. Unvi. Vol. I., No. 7.

This result supports my opinion, that the production of aroma is caused by a certain enzyme. As to oxidising enzymes their presence can easily be demonstrated. When tea leaves are treated with strong alcohol until the tannin is entirely removed, and then treated with distilled water, the aqueous extract thus obtained behaves as follows :—

		Guaiac tincture.	Guaiac plus H_2O_2
40	(aroma)	blue	deep blue
50	(do)	do	do
60	(very weak)	do	do
65	(no aroma)	do	do
75	(do)	no coloration	no coloration
100	(do)	do	do

Since the leaves kept at 65° developed no aroma but gave still the reactions for oxidase, and peroxidase, it appears that other enzymes than these are concerned in the production of aroma.

POST SCRIPTUM.

As Mr Katayama having had to break off his studies on account of his departure for India and Europe, Prof. Sawamura made a further experiment upon which he reports as follows :—

"I extracted 156 g of fresh tea leaves with 900 c. c. of absolute alcohol and 147 g with 1 litre of 20 per cent alcohol. The former extract was evaporated to dryness and the residue dissolved in water (A). The latter extract was precipitated with ether-alcohol (B). By adding the precipitate B containing the enzymes to the solution (A), an agreeable aroma characteristic for the prepared tea was produced."

This result is a further confirmation of the view, that the tea aroma is caused by the original enzymes of the leaves. But the true nature of the enzymatic process requires further study. The most probable supposition is, however, that a peculiar enzyme splits a certain glycoside present in small quantities and that one constituent thus liberated yields by taking up oxygen the aroma of tea. Y. KOZAI.

—*Bulletin of the Imperial Central Agricultural Experiment Station, Japan, Vol. I, No. 2,* Oct. 1907.

A NEW COTTON FROM THE SOLOMON ISLANDS.

"MAMARA": MORE PROLIFIC THAN CARAVONICA.

We have this week received from Messrs. Sturmfels, Limited, wool and produce broker, of Brisbane, a sample of a new cotton grown in the Solomon Islands, which promises to be a rival of Caravonica in its prolific yields and ease of cultivation. We have examined the sample in question and find it is, as reported, a fines white silky cotton, and one which certainly ought to command the high price at which it is valued. It is a pity, however, that the cotton has not been sent to us just as it was gathered—in the boll—so that the quantity of lint, per boll and in comparison with the bulk of seed, might be judged. The staple is a good average one —about an inch in length. This "Mamara" Cotton will be found duly advertised in the September issue of the *Tropical Agriculturist.*

Meanwhile we publish further particulars of it in the report forwarded to us, from Messrs. Svensen & D'Oliveyra, who have been growing it so successfully in the Solomon Islands, as follows :—

Guadalcanar, Solomon Islands, 10th June 1909.
Messrs. Sturmfels Ltd., Greek St., Brisbane, Queensland.

GENTLEMEN :—Herewith please find samples of our new hybrid perennial Cotton "Mamara" which has been grown by us here with great success. It yields a fine silky fibre similar to Caravonica No. 2 valued in Europe at 1s. per lb. We have grown it principally as a catch crop between coconuts without cultivation, other than weeding, and we have obtained a return of 300 lb. of lint per acre. This variety of cotton only grows to an average height of about 6 feet whereas the "Caravonica" reaches from 15 to 20 feet. We have grown the "Mamara" and "Caravonica" alongside each other and find that the former invariably produces the heavier crop. Our rainfall is about 80 inches per annum, half of which falls during, January, February and March. A small crop of "Mamara" is secured six months after planting and in January the bushes should be heavily pruned back. We feel assured that by trying the Mamara" variety in suitable localities proprietors of plantations will secure a very valuabe cotton ; and if the seed is returned in the shape of manure, very little is taken from the soil. We shall always be pleased to give any information required, to intending growers.—Yours faithfully.

(Signed.) SVENSEN & D'OLIVEYRA.

After this satisfactory report we would like to see the Peradeniya Department and enthusiastic growers of cotton in our midst, like Dr. H. M. Fernando and others, making a trial with the new hybrid species in Ceylon.

NEW RAMIE DEGUMMING PROCESS.

Ramie fibre is one of the best in the world. It produces cloth of a texture that can scarcely be told from silk and stronger than linen. The chief drawback in connection with its production is the difficulty of cleaning the fibre from the gum which is contained in the plant. Years of study, and hundreds of thousands of dollars have been spent in the effort to produce an adequate "degumming process." Some twenty-five years ago about $40,000 was expended on a ramie plantaion situated near the present site of the Olaa Mill, the cleaning machinery being located in Hilo. Tho ramie grew well and tho fibre was of first-class quality, but the degumming process was not successful, resulting in total failure. That a successful degummer will some day be discovered is a moral certainty, in which case there is no reason why ramie should not become a staple and profitable product in Hawaii. It may be that even now the long looked for process may have been found. U. S. Consul Charles Denby, of Shanghai, China, thinks it has, and has so reported to the State Department. He says that the operation is simple and lasts only ten minutes. The ramie is first placed in a vessel containing boiling wear to which is added a secret composition. After boiling four and one-half minutes it is washed, bleached, and thoroughly degummed. A decorticating machine has also been invented by a Mr. Smith which, it is claimed, will do the whole of the work now done in the fields by hand, except cutting and carting. A fibre Company has been organised at Shanghai to manufacture ramie goods. We suggest that this is a proper subject for investigation by the Hawaii Experiment Station. Doubtless, Mr. Denby would, upon request, furnish detail information concerning cost and methods, and give names and addresses of inventors.—*Hawaii Planters Monthly*, May 15.

"FERTILISERS AND MANURES.*"

BY A. D. HALL, M.A., F.R.S., DIRECTOR OF THE ROTHAMSTED EXPERIMENTAL STATION, &C.
[REVIEWED BY JOHN HUGHES, F.C.S., AGRICULTURAL ANALYST.]

This book, which is gracefully dedicated to Sir Charles Lawes-Wittewronge, Baronet, "who has shown in other fields tho distinction and imagination which marked his father's work for agriculture," the only son of the late Sir John Lawes, Bart., is intended by the author to be a companion to his previous work, "*The Soil.*" Though published primarily for farmers and the senior Students and Teachers in our agricultural schools, the book is written in such a clear, simple style and treats the principles of manuring in such a useful practical manner that it should be equally appreciated by Colonial planters of Tea, Coffee, Sugar, Rubber, Cotton, Cacao and other semi-tropical crops. It possesses the special advantage of making use of the valuable experimental researches that have been carried on, on a thoroughly systematic method, at Rothamstead for so many years. Mr. Hall endeavours to help men to a greater skill in the selection of the fertilisers and manures best adapted for particular soils and crops, and employs the results of the Rothamstead experiments by way of illustrating his views. There are, in fact, 103 separate tables of experimental results, and the illustrations of the growth of crops and plants in pots, though not many, are very interesting.

The first chapter is taken up with a review of the early history of Manures, the theories of plant nutrition, the introduction of artificial or prepared fertilisers, and the assimilation of plant food from the air and from the soil ; and attention is directed to the statement made by Liebig to the British Association in 1840 that the carbon compounds, which constitute fully 95 per cent. of the dry matter of the plant, were obtained from the atmosphere by the plant and that only about 2 per cent. in the form of mineral constituents was obtained through the roots from the soil. The author next proceeds to consider the three essential ingredients of all Manures under their respective headings and in the order of their agricultural importance, namely : Nitrogen, Phosphates and Potash, to each of which separate chapters are allotted. Naturally, the soluble and quick-acting fertilisers,

* JOH MURRAY, 1909—5s nett.

such as Sulphate of Ammonia and Nitrate of Soda, are very fully considered, their respective advantages for certain crops and certain soils are clearly pointed out. Thus the former, boing the more soluble, is best adaptod for districts with a small rainfall and where immediate effect is desired as in the case of the top dressing of cereal crops. The continuous application of Nitrate of Soda on soils inclined to clay has a bad mechanical effect owing to deflocculation. Sulphate of Ammonia, though most useful as an ingredient of compound manures if applied alone continuously on soils deficient in lime, causes a distinct acidity which in time renders tho land positively barren.

The various waste products, such as Soot, Shoddy, Hoofs and Horns, are severally treated of. In regard to Shoddy, Mr Hall states that Hop and Fruit growers regard it as the best substitute for farmyard manure; indeed for fruit he writes that it is often regarded as preferable to ordinary dung. Probably, if obtainable, Shoddy would be an excellent manure for Tea and Coffee as it would supply a steady and continuous supply of Nitrogen. The chapter on Phosphates is of particular interest as the special advantages of Bone Meal, steamed Bones and Bones treated with Sulphuric Acid are fully enlarged upon. The author considers ordinary Bone Meal—that is, the whole bones crushed into meal—is rather over-valued; whereas steamed bone-flour hardly gets justice done to it. Planters, who havo used Leechman's steamed Bones as formerly prepared in Ceylon, will probably fully agree with this statement. Refereuce is made to Lawes, who, in his proof of evidence in connection with his Patent for the manufacture of Superphosphate in 1842, stated that he found no good effect from the use of a considerable dressing of Bone dust to his Turnips on his particular soil, but that he found most remarkable results from the application of his own manure Superphosphate.

In considering the action of the various phosphatic manures, Mr Hall very wisely states that the most important factor to be taken into account is the character and composition of the soil. The choice between Superphosphate, Basic Slag or Bone Meal must be determined by the proportion of carbonate of lime in the particular soil and the relative wetness or dryness of such soil. Before applying Phosphates in the form of Superphospate it is necessary to ascertain that the soil contains a sufficient supply of Carbonate of lime in order to ensure the precipitation of the water soluble Mono-calcic phosphate into the condition of di-calcic phosphate, resulting from contact with Carbonate of lime. Mr Hall further states that on acid soils, on some clays, and on many sands and gravels, in which there is such a deficiency of Carbonate of lime, the soluble phosphoric acid becomes precipitated as iron or alumina phosphates which possoss a much lower solubility in the soil water, and are, therefore, less available to the plant.

The properties of Basic Slag are naturally fully described and its usefulness for damp heavy clays or sour wet soils deficient in lime is specially pointed out; but Mr Hall admits that in England there is a prejudice against the use of Basic Slag on the lighter soils, the sands and gravels, which are deficient both in lime and vegetable matter. On such land, he points out, there is a very general preference for phosphatic guano, steamed bone flour and the new Manure Basic Superphosphate. As regards *Potash*, its use on the lighter soils, the sands and gravels is generally recommended; but on stronger soils its application is scarcely likely to be remunerative, and the use of Nitrate of Soda as a source of Nitrogen will liberate enough of the locked-up Potash in the soil for the needs of ordinary cereal crops.

Farmyard Manure, its composition, properties, the loss of Nitrogen during fermentation, its fertilising value and physical effects upon the soil, the long duration of its fertilising action are fully described, and particulars of the cost of its production are given, namely, from 9s 4d to 11s 8d per ton: figures which may be interesting to those with cattle establishments in Ceylon, but are certainly far above what is usually considered a fair price to be paid by the in-coming tenant on taking a farm.

Chapter 9, which deals with the use of lime, marl, chalk, gypsum, ground lime and ground limestone will afford most interesting reading to all those who cultivate soils which are naturally deficient in lime; and it is important to note, the author states, that in such cases the particular form in which lime should be applied can only be decided after an analysis of the soil. The system of Manuring Crops forms the subject of a separate chapter and the roader will derive interesting and useful information by learning, first, what ingredients the various crops remove from the soil and how the ingredients essential to such crops can be most economically supplied.

Particulars are given of the unit mothod of valuing fertilising materials which cannot fail to be useful to those making large purchases of special fertilisers. Mr. Hall has also some useful remarks in reference to semi-tropical crops, such as Tobacco, Sugar Cane, Tea and Cotton; but he candidly admits that it is very difficult to lay down any general rules for the manuring of such crops because the conditions of soil and climate are subject to extreme variations, so that entirely different methods of treatment have to be pursued in different countries.

The book is provided with an excellent index, which is always a great advantage when seeking information; it may be confidently predicted that every farmer or planter who obtains a copy will be greatly edified by a careful perusal, and will certainly not regret its purchase.

COTTON IN UGANDA.

The cultivation of cotton in this Colony is spreading rapidly and will, it is expected, soon become a magnificent industry. This was the view of Mr. Dawe, of the Agricultural-Botanic Department, who was recently here, and is endorsed in the report of H. E. the Governor Sir H. Heskett Bell. The great want would appear to be means of communication. According to the Governor every

peasant is willing to grow cotton on condition that he is not obliged to carry his crop on his head for more than a 2-days' journey. Considerable crops of cotton are said to be left to rot owing to the difficulty of conveying them. H. E. looks forward to the time when the distressing system of human porterage will become a thing of the past and the nativos of Uganda, ceasing to act as beasts of burden, will be in a position to turn their attention to the cultivaion of the soil.

PRESERVING COPRA FROM MOULD.

In answer to a query in the *Journal of the Royal Society of Arts* the following reply appears in the August 13th number :—

Copra.—" Malay " will be interested to hear that M Bybowski, Director of the Paris Colonial Gardens, has been conducting experiments in the preservation of copra from mould by means of sulphurous acid. Some samples so treated in 1905 still show no signs of deterioration. In June last he made a further trial on a consignment of 3,000 coconuts imported from the Malay Archipelago. The nuts, after being cut in two, were exposed to the action of the sulphurous gases by means of the Marot apparatus. The operation has been repeated on successive batches, and it now seems to be proved that under the sterilising influence of this gas the original condition of the copra is maintained.—H.M.

GRASS AND FRUIT TREES:—ROUND COCONUT PALMS, &c.

We are indebted to Mr. John Hughes for the following useful reminder and information :— " The enclosed cutting is from a recent issue of the *Field* and may be useful for the Supplement to the *Tropical Agriculturist*. You remember asking me some years ago what my opinion was in reference to grass being allowed to grow between coconut trees, and I remember writing you that I considered grass had a bad influence as it seemed to smother the young rootlets of newly-planted trees. Since your query I have paid a visit to Homburg and the Rhine districts and noticed that orchards in Germany are not in grass as so common in this country, but are always kept under cultivation—frequently potatoes being raised, at other times gooseberry or currant trees between the apple trees. The important point is to keep the ground under cultivation rather than allow grass to spring up and smother the roots of the fruit trees." The extract from the *Field* is as follows :—

Effects of Grass on Fruit Trees.—Notwithstanding all that has been said and written in condemnation of the practice of allowing grass to cover the soil right up to the stem of fruit trees, it has had very little effect, the number of young trees that are to be seen in all parts of the country fighting for very existence against grass being disheartening to those who would bring about a better state of things. Last week we saw a large orchard planted about eighteen months ago with standard fruit trees, every one of which not only bore evidences of semi-starvation, but looked sick almost beyond recovery. It did not need actual demonstration by experiment at Harpenden and Woburn to satisfy any observant cultivator that grass was bad as a root covering for young trees. It is not a question of water at the root, for there has been more than enough rain this month to keep the soil saturated; yet those trees that are grass covered are suffering where those in open soil are fat and well. We advise all who have fruit trees in grass to keep the surface of the soil for at least a yard from the stem quite free of grass and weeds. The turf should be removed at once, and if it is sliced off with a spade taking care that in doing it the stem is not bruised, the tree will certainly be benefited. When once the soil has been bared a boy with a hoe once a month or so will be able to keep grass and weeds from again getting possession. Not only is there a difference in the growth of the trees, but the fruit is better in quality and about 100 per cent more in quantity from trees that are on open soil compared with those on grass.

TOBACCO-GROWING IN TRINCOMALEE DISTRICT: A PROMISING EXPERIMENT

We are glad to hear of a successful—or at any rate very promising—tobacco experiment at Mr. G. N. Molesworth's estate (Uppar) near Trincomalee. We under stand this planter, who with the late Col. Molesworth was fortunate in the land he selected and has added to good fortune enterprise of various kinds, has been growing tobacco experimentally over 20 acres during the past two or three years and has turned out excellent cigars. Specimens seen are of fine flavour— approximating to good Indian—and only require to be made of even colour, and a little less tightly rolled, to command a good market. We hear, however, that already an offer of 18 shillings per 100 (provided at least 25,000 such cigars were supplied) has been made from home. We do not know that any contract was made; but we understand Mr. Molesworth has leaf stored now of two or three years' growth, and extension of the area under tobacco—on the banks of the Mahaweliganga—will depend upon results.

CULTIVATION IN SOUTH COORG.

In recommending the growing of leguminous weeds in coffee, Mr Anstead, the new Scientific Officer, is reiterating the advice of other experts in the past. To Mr B Nelson, of Shencottah, belongs the credit of having introducod, *Erythrina lithosperma*, and having successfully grown coffeo under it, the practice followed being to mulch the land with the loppings of the trees. Dr. Watt condemned this owing to the plant having in some localities favoured the multiplication of white mealy bug, and advocated the growing of *Albizzia stipulata* instead. Professor Herbert Wright, of rubber fame, favoured Mr Nelson's practice. "Green manuring" has been carried out in a small way in the District and has been found especially beneficial in raising supplies in bare places.

Though black bug occurs infrequently in these parts, it is matter for congratulation that the Pulney scale insect has not yet made an incursion into the district. Black bug usually attacks shade trees and subsequently the coffee under them. As the bug usually recurs on the same tree, season after season, the best policy would seem to be to cut it down and destroy it with fire.—*M. Mail*, Aug. 31.

SWAMP CULTIVATION.

SOME EXPERIMENTS IN S. INDIA.

The marshes or deltas of the Irawadi in Burma, of the Brahmaputra and Ganges in Bengal, of the Godavery and Kistna and Cauvery on the East Coast of India, and of the small and large streams on the West Coast, give employment and food to many millions of the inhabitants of India, and they also bring great wealth to the country, because the rice and jute and other products of the marshes are exported. It is no exaggeration to say that the cultivation of swamps is the most important and the most remunerative work in the country. I am afraid, however, that other lands have realised this fact better than India. Scientific cultivation of swamp lands is still in its infancy in this great country. Egypt has been for thousands of years one of the world's great granaries, because from an early stage of her history the fellaheen or ryots of the country have used the waters of the Nile for their protected fields and have thus turned swamps into gardens. What has been done in Egypt can be done in India by co-operative effort.

Perhaps nowhere else in the world have such wonderful results in the cultivation of swamp lands been achieved as in the deltas and adjoining lands of the Elbe, the Weser and the Rhine, or in Schleswig-Holstein, Frisia and Holland. . . . India has not such high tides to contend with as the residents of German marshes. Yet, so far as I am aware, there is

NOT ONE SINGLE SLUICE CONTROLLING THE DRAINAGE WATERS

of the many marshes of India. By the way a scientist gave me some unique information about the massive Holstein cattle, among which there are the best milching cows in the world, some cows yielding 65 to 70 quarts of milk a day. Holstein cattle have large black patches, varying with white spots all over their satinlike skin. I asked my scientific friend whence these beautiful white spots are derived. He replied that ages ago some herdsmen from India sought to improve their stock. After years of wandering, they reached Holland and Holstein. The black herds that they saw there pleased them, and so by interbreeding the white cattle of India with the black Holstein cattle a new breed of cattle was produced—the Holstein breed. Indian cattle even now are sent to other lands for breeding purposes. Why may not the same thing have been done ages ago?

Missionaries, as a rule, are very keen on improving the condition of the people among whom they live. A book might be written on the material benefits conferred on India by them. I need only allude to the great industries of the Basel Mission. Ever since I first came to India, nearly twenty-eight years ago, I have tried to do something to improve the condition of the poor and needy. While a Missionary in Kurnool, more than fifteen years ago, I introduced there the weaving of a finer and more artistic pattern of the Kurnool rugs. By this means the poor weavers could earn better wages, and that industry continues to this day. Up in the Kistna, Guntur and part of the Nellore Districts millions of palmyra palms grow. The people always used the old leaf-stalks for fuel, and were not aware that they were virtually burning money. By the kind help of a German businessman of Madras, I was enabled to introduce

THE PALMYRA FIBRE INDUSTRY

into these districts, and the poor people in their villages on the sand dunes along the coast have earned lakhs of rupees during the past eight years, and the fibre industry has became an established industry in this part of India, with headquarters at Coconada.

Some four or five years ago, when Sir James Thomson was Acting Governor of Madras, Lord Ampthill being the Acting Viceroy, it was my privilege to visit Sir James and talk with him about the present Guntur District. I had known Sir James when he was a popular Sub-Collector in Guntur in 1882. During our conversation I told him about the

RICH EXTENSIVE BAPATLA SWAMP,

nearly twenty miles long and from two to five miles wide. I asked him why Government did not make that swamp productive. His Excellency replied that India could not spend so many millions on agricultural improvement as America does. Then he asked me how I would improve the swamp. I said that the way of success lies in proper drainage works and in diking. This conversation led His Excellency to propose to me that I should try, on a small scale, what can be done in swamp cultivation. I agreed to make

AN EXPERIMENT ON A FIVE-ACRE PLOT.

One of the lowest spots of the swamp was chosen for the experiment by the D. P. W. Engineer. I diked the same, Government paying the cost, which was less than R300. Many prophesied that I would fail, for they said:—"You have only turned the five acres into a tank and you can never raise a crop." I felt sure that the experiment would succeed. After planting the plot, heavy rains in the uplands brought floods of water into the swamp, and the same was turned into a large lake. The growing crops on thousands of acres were badly damaged or wholly destroyed, while my dikes kept out the waters and my crop was saved. Later in the year the conditions were reversed. There was a drought. The water in the Kistna River was insufficient to fill the canals and many crops were in a poor state and all were badly damaged for lack of water. We had plenty of water stored in the ditches around our field, and, by lifting this water into our field, we always had enough water for the growing crop. It will be tiresome to enumerate all the experiences of that year. Suffice it to say that we reaped the best rice crop grown that year near Bapatla. Drought had so injured the crops on even the best of fields that the straw of those fields was stunted in growth, while mine was long and the heads were full of fine grain. Everybody wondered that it was possible to do such successful farming under such adverse circumstances.

Success made me venturesome, and I now asked to be permitted to try the experiment

ON A LARGE SCALE.

Fifty acres were again set apart for the experiment, but unfortunately I fell ill and had to go on leave. Yet my *lcoum tenens* cultivated the land. We found that by protective works of a primitive kind we could get double the harvest that other ryots reaped. Our experiment was keenly watched by the ryots, and now there are thousands of applications for lands in the Kutcherry, and the question is how are Government going to satisfy all the thousands who are anxious to get swamp land for cultivation. Village officials tell me that since I began my experiment the

INCREASE IN REVENUE PAID TO GOVERNMENT

in three villages alone is about R12,000 a year. There is no reason in the world why the increase in revenue from this swamp should not be over R1 lakh when the D.P.W. finish the protective and drainage works that are all ready now to be taken in hand. But even when these public works are finished, yet it will be

WISE FOR THE RYOTS TO DIKE THEIR LANDS,

for the following reasons :—

(*a*) Dikes are the best fences in the swamp, and on the dikes much can be grown that will be valuable. Unless the lands are protected the cows and buffaloes, but especially the sheep, will be driven on to the lands and eat away any green shoot they find. I have had more than one crop thus destroyed. Dikes will enable the ryot to reap at least two crops from his field every year, while without dikes he will find it very difficult to get even one good crop ;

(*b*) then the ditches solve the question of drainage of the field. In swamps there is great danger of *zoudu*, or salt, destroying the soil, because this dangerous salt rises to the surface where there is stagnant water on the fields. The ditches also contain enough water to supplement the supply from the irrigation channels in time of drought.

THE LESSONS LEARNED

by my experiments so far in swamp cultivation have been first that swamps can be successfully cultivated if dikes are built, and any ryot can dig these dikes because the cost is not prohibitive. Then the ditches offer the only solution of successful drainage, even if Government should dig large drainage channels. Thirdly, the water in the swamp ought to be kept in the ditches as much as possible, for water is too valuable to waste on this land. Only surplus flood water ought to be permitted to flow away Sluices ought, therefore, to be placed in the drainage channels. Again, the ryots need object lessons in cultivation more than anything else. When it is demonstrated to them, in their own fields, that one can grow two blades of grass where now, with difficulty, only one blade grows, he sees how advantageous scientific cultivation of the soil is, and he will imitate the teacher who has given him a practical lesson in agriculture. The ryot is not so conservative that he is not willing to learn. He is only too willing to go ahead, only he first of all wants to be sure that he is right.

My experiments in swamp cultivation could never have been so successful, in spite of many failures, if I had not had the sympathetic help of Government....India today is ripe for a revolution in agriculture.......This revolution has changed farming in Germany, Australia, and especially in America. The revolution so much to be desired in India is co-operation in agriculture. At present I am only waiting for Government to approve of my plans. Then I shall form the Bapatla Co-operative Agriculture Association, a co-operative Association that will demonstrate that by the cordial co operation of brain and brawn wealth can be produced.

GEO. N THOMSSEN.

—*M. Mail*, Aug. 20.

THE OTHER NEW RUBBER COAGULANT.

DISCOVERY OF GREAT COMMERCIAL INTEREST.

The publicity given to the discovery made by Mr O Aubrey Elias, F.C.S., of a chomical re-agent which will quickly and effectually coagulate rubber milk without imparting any deleterious effect to the finished product, has aroused considerable interest in scientific circles.

Mr C T Gardner, dispenser at the Miller General Hospital, Greenwich, who has given to the public the result of his analysis of specimens of rubber treated under the new process said the standard of rubber qualities was fine Para hard cured, which consisted principally of caoutchouc, a substance bearing the chemical empirical formula $(C_{10}H_{16})_n$, with about 1·3 per cent of resin, a little water—say, about 0·75 per cent—from 3 to 4 per cent of proteid, and yielding from 0·2 to 1 per cent of ash. There was also colouring matter present and sometimes foreign impurities. Inferior rubbers might contain as low as 50 per cent of caoutchouc. The presence of proteid matter in the latex might be shown by a very pretty test known as the xanthoproteic reaction. In this test nitric acid was added to the latex, and the liquid was boiled, when it turned yellow, the ohange in colour being due to the formation of xanthoproteic acid. Ammonia added to the fluid caused it to become a rich orange. Rubber containing proteid, when diffused in chloroform, left an insoluble coagulum, varying in amount according to the quantity present ; in other words the proteids were non-diffusible. Those proteids were highly complex bodies which in the tree were built up from the simple chemical compounds acting as nutritive material to the tree. The particular kind of proteid in the latices of rubber-producing plants was an albumen coagulable by heat at 70 degrees. The coagulant invented by Mr Elias seemed to practically, if not altogether, eliminate the undesirable proteid. "For this reason," added Mr Gardner, "I believe this coagulant will produce a revolutionary effect on the rubber world."—*Financial Times*, Sept. 3.

PLANTING NOTES FROM PORTUGUESE WEST AFRICA.

By Lieut.-Col. J. A. Wyllie, F.R.G.S.

I.

Cacao, &c, in St. Thome and Principe.

St. Thomé, Portuguese West Africa, July 22.

Dear Sir,—When passing through Colombo two or three months ago, I promised to send you some notes on the Rubber Exhibition at Para, whither I was then bound. But as that Exhibition has not yet opened, and may not open for some months to come, perhaps it may interest you and your readers to have instead a few particulars of these comparatively unknown islands, where I am passing the time until I can receive from Para definite information as to the opening of the Rubber Show there.

Since Sir Richard Burton, many years ago, published his "Glimpses of Feverland", very little has appeared in English about the Portuguese and Spanish island colonies in the Gulf of Guinea. Recent events, however, in which I regret to say certain Britons (or Americans?) have played a part where hysteria usurps the functions on sane judgment, have drawn attention to the unsuspected existence and the remarkable prosperity of a colony which is not a British but a Portuguese possession. This discovery indicated something irregular, improper, contrary to the order of Nature, something that required looking-into ; to account for it there must be a screw loose somewhere ! Accordingly the busybodies whose self-imposed task it is to pry into other people's affairs—*desfacedores de entuertos*, as good old Cervantes called them in their great prototype Don Quixote, soon furnished the enquiring British public (who had not as a matter of fact troubled to enquire at all) with a cut-and-dried solution.

Apparently, judging from questions asked in Parliament and out of it, the humanitarian creed seems to assume that Great Britain has not merely a right to censure a foreign power in respect of arrangements concerning her internal colonial administration alone, but a duty to enforce upon her the ill-thought-out ideas of this noisy school of faddists. Up to this stage, it is the Portuguese islands of St. Thome and Principe which have been

SINGLED OUT FOR HOSTILE CRITICISM,

their carefully organised system of indentured labour being denounced as a Modern Slavery. Tho Spanish colony of Fernando Po, forming one of the same group of islands, and furnishing likewise its quota of cacao to the world's markets, has for the present escaped attention. Its turn may come; but so far no marked inclination to tackle the German Empire on the subject of labour in the adjacent colony of Kamerun, also a cacao-producing area, has been displayed. And, still more remarkable, the really justifiable outburst of indignation against the methods of the Belgian Congo has evaporated, leaving matters much as they were. Poor little Portugal alone has to stand up as an Aunt Sally to furnish a mark for the missiles being heaved at her. All this might be amusing enough, to those not directly interested in the case; but in point of fact it does concern Ceylon and Malaya, for this year or next their turn may come, and their labour system, which has many features of resemblance to that of the Portuguese island colonies, may be cited to justify its existence

BEFORE THE HUMANITARIAN TRIBUNALS.

A glance at the map will show the position of the islands. The equator passes between the southern most of the group, the Ilha das Rolas, so-called from the numbers of wild pigeons on it, and the principal island—St. Thome itself—an island containing an area of about 612 square miles, its greatest length from North to South being 33 miles, and its breadth 21. Seventy-five miles to the North of St. Thome lies Principe, less than half the size, and about as far again to the North the Spanish possession of Fernando Po, half-way from Principe to the mouth of the Niger. To the East, on the nearest mainland, lies the German colony of Kamarun.

The scenery of the islands is of singular beauty, the almost land-locked bay of Saõ Antonio de Principe, the first port reached on the southward-bound voyage after leaving Cape Verde, reminding one strikingly of many points in the Mergui Archipelago or of the anchorage at Port Blair in the Andamans. Forest vegetation to the water's edge, the steep hill-sides covered with cacao plantations interspersed with the naked trunks of huge primeval trees known locally as

AMOREIRA AND AZEITONA

(fanciful names given to giant growths very distantly resembling the little European trees to which these designations by right belong), with here and there the familiar forms of the jak, mango, tamarind, and bread-fruit tree, grown partly as shade for the cacao, partly for food for the labourers. On the little spurs and underfeatures of the hills stand forth the houses of the roceiros or planters, artistically coloured pink, or blue picked out in white, so as to recall memories of Lisbon to their residents in exile, for every true Portuguese colonist, as Sir Richard Burton remarks, all the world over tries to make his new abode resemble Lisbon. The roofing of these chalets, however, is almost invariably composed of the pattern of tiling known to us in India as Mangalore tile, and for the moment creates the illusion that one has never left India after all.

Nothing could be more striking than the contrast between these islands and those of the Cape Verde group, at two or three of which the steamers of the Empreza Nacional de Navegação touch on their way south. This line, I may mention in passing, is practically the only one (thanks to a misguided ultra-protective tariff—of which it is to be hoped Portugal will repent before she kills off the sickliest of her colonies and cripples the stronger ones) which carries passengers and freight to these ports. Travelling by it, one has facilities for noting the great diversity of character of the various colonies not only in aspect but also as regards soil, vegetation, and population.

ST. VINCENT, FOR INSTANCE, IS A BARE DESERT ISLAND,

owing its sole importance to its position as a coaling station and a centre of junction for the vari-

ous submarine cables, its European inhabitants being largely English in consequence. A most uninviting spot, and would be worse were it not for a few artesian wells which have enabled oases of market gardening to be created here and there to give a touch of colour to the pervading brownness of the place. The very drinking water has to be brought by steamer from the neighbouring

ISLAND OF ST. ANTON

an island which some day or other will become a formidable rival to Madeira, possessing as it does a marvellous climate and a fertile soil, with boundless possibilities in the making of a health and pleasure resort. S. Thiago, a night's journey further south, has a more fertile soil, and a very similar climate. In fact, one of the things that strikes a new arrival from India is the extreme temperateness of the sun's rays, although the latitude of these islands is somewhat the same as that of Goa. Even in St. Thome and Principe it is hard to realise, as far as sensations go, that one is in the tropics at all. Praia, the chief town of St. Thiago, stands high on a ridge with precipitous sides, falling down to valleys low and irrigated, rich in tropical cultivation. These valleys, however, are comparatively limited in extent, and as the phenomenon of "the marvellous fecundity of the half starved" is painfully evident here, the foodstuffs produced are not sufficient for the mouths that have to be fed. The main export of the island is the *purgeira*, the weedy hedge-plant we have in India and Burma—*jatropha curcas* is its botanical name. Its seeds have a certain market value, but I should fancy a low one. The town of Praia is well-paved, and regularly laid out. It is clean on the whole, but though windswept and cool, it has an unenviable reputation for bilious remittent fever. Famines are of frequent occurrence, the rainfall being uncertain. The dress both of the men and the women is semi-European, likewise their housing and mode of living on the Portuguese model. But they do not look as if they got enough to eat, and those who know them best tell me this is exactly so.

This suggests a digression which will bring me round presently to the story of

ST. THOME AND ITS LABOUR SUPPLY.

On my arrival at Lisbon from Burma I was informed by friends connected with St. Thomé that the Great-British Humanitarian was again on the war path, scalping knife in hand. A copy or extract of a letter from the Lisbon correspondent of the *Times*, published some time early in June, was shown me. Its tone was fair and moderate throughout, but it closed with the somewhat ominous remark that Mr. W. H. Nevinson meant to stick to his guns; and in the *Times* of June 5th had renewed his charges of slavery against Portugal. I could do nothing in Lisbon, but agree to go to St. Thomè and see what could be done there. I have not yet obtained a copy of the issue referred to, but that does not now matter, for the Lisbon *Novidades* of June 7th, received soon after my arrival here, has a paragraph quoted from the *Times* of the 5th idem, to the effect that a gang of "slaves" had just been landed at St. Thomé in chains and sold by public auction to the highest bidder! This evidently was the substance of Mr Nevinson's accusation. To anyone acquainted with the indentured labour system, the impossibility of the sale by auction, at least, was patent. As to the landing of the men in chains, it was not absolutely incredible, for they might have been an unruly lot on board, but it certainly did not tally with my own experience of the methods of the emigration agents nor of the Empreza Nacional. I had travelled all the way from Lisbon with a consignment of prisoners on board—men sentenced to transportation and being convoyed to St. Paul de Loanda to undergo their sentences. I am told these men were brought on board manacled at Lisbon (and rightly so); but when they first attracted my attention, they were absolutely free, and were entertaining themselves, dancing to the music of a guitar which one of their number was playing. Moreover, at Praia de St. Thiago I made it a point to visit the emigration agency and (with permission freely accorded me) to inspect the contract-deeds and subsidiary vouchers of

A GANG OF MEN AND WOMEN

just then being engaged for work on Principe—a much worse island, by the way, than St. Thomé itself, being badly stricken with sleeping sickness, from which St. Thomé is free, the *glossina palpalis* being abundant in the former and absent from the latter island.

A CHOICE BETWEEN DYING OF STARVATION AND LIVING IN A BAD CLIMATE.

Not only were the papers of these people in perfect order according to the Portuguese Code, which is an admirable one in all details, but the people themselves were quite accessible. They travelled by the same ship as I did, and when next morning one of their number, taking me for the ship's Doctor, stepped on deck leading a young negress by the hand and asked me to prescribe for her as she had a bad pain in her inside, I passed her on the surgeon and engaged the man and several others of the gang who had crowded round in conversation about their agreement. They fully grasped the situation. Asked if they were aware than probably not more than half of them would ever return to Cape Verde, they asked by way of reply what would happen to them if they stayed at home and did *not* go to Principe. It was a choice between dying there of starvation, and living a few years in a bad climate, but well paid, well fed and well treated, with a fair chance of return after all. Needless to say, when that party went ashore, they did so as free men, and in good spirits as any one could well be. I landed there too, but found that the Governor was too ill to receive visitors, and as the place was dismal and uninviting—a half-ruined town built on a swampy site the solid crust of which was so thin that the land-crabs breaking through it on the roadsides threw up small volcanoes of watery mud from a depth of perhaps six inches at the outside—a shower of the chin watery rain the islanders in their curious hybrid dialect of Spanish-French founded on Portuguese call *leche de voador* (flying fish milk—the resemblance being to the spray dropped from the fish as it takes its first flight from the water) decided me to return to the ship as soon as I had exhausted my supply of films for my Kodak.

MR. NEVINSON'S ACCUSATION.

Shortly after my arrival at St. Thomé I called on the Governor of the Colony, Senhor Vieyra de Fonseca, a naval officer of long service on the African coast, with a distinguished record of civil work in addition. We discussed the paragraph containing Mr. Nevinson's accusation, and he gave me full permission, when writing to *The Times* on the subject, to contradict the story on his autbority, using his name. Never in modern times had any indentured labourer been landed in irons at tbis port, nor had anything resembling a sale of slaves by auction taken place. Outside Government House I made further enquiries, but the nearest approach to a clue I got was from one of tbe principal shipping agents in the town, who told me tbat a Scotch Engineer—easily identifiable, but whose name he could not then give me—employed on board a vessel recently in harbour, had been boasting tbat, to "draw" his friend Nevinson and test the limits of his credulity, he had composed the story out of his own head and posted it from St. Thomé. The story contained much more harrowing details, ears cut off and a variety of mutilations, but these seem to have been rejected as a bit too strong for the public to accept. Let us hope that this is the explanation, and that jokes of tbis kind will not be repeated, for they do a lot of harm before they can be exposed.

"A MODERN SLAVERY."

I only know Mr Nevinson through his writings and his speeches to the seditionists of India, made during his tour in that country a couple of years ago. These in themselves write him down a luminary of that school of tbought (or rather of tboughtlessness) that for want of a better name one migbt style the Neo-Anarcbist school, a sect comprising our Keir Hardies, our Rutberfords, and several more of the same kidney whom I need not mention. Kind-hearted mild-mannered men in private life, who neither handle high explosives themselves, nor actually counsel others to do so, but who expound a doctrine—the practical expression of which is tbe bomb and the revolver. "Anarchist," in fact, is what Mr Nevinson in his interesting but somewhat misguided and too often malicious book "A Modern Slavery" claims himself to be; so he can hardly quarrel with the designation. Should he challenge it, here are a few samples of his creed:—

"England can no longer be regarded as the champion of liberty or justice among mankind ...If sbe spoke of liberty, the nations would listen with a polished smile (Modern Slavery, 1906, p. 208)."

"Rebellion is always good. It always implies an unendurable wrong It is the only shock that ever stirs the self-complacency of officials (Op. Cit., p. 15)."

"This" (apropos the Spanish Government sending back some servicaes to Principe from Fernando Po) "is one of the things which makes us all anarchists".."wherever you touch Government, you seem to touch the devil (p.201).'

"Slavery is not a matter of discomfort or ill-treatment, but of loss of liberty. .it might be better for mankind that the islands should get back to wilderness than that a single 'slave' should toil there" (p.210).

Teachings of this order simply

REDUCE HUMANENESS TO AN ABSURDITY,

The so-called "slave," *i.e.* the indentured labourer, works for a wage and is paid in food and clothing as well as—gets, in fact, better terms in St. Thomé and Principo than—he does in Ceylon and Burma; and the planter has a right to look to Government or to the tribunals to support him in his claim that the labourer shall fulfil his part of the contract as faithfully as the planter does his. In India or Burma, and I presume in Ceylon as well, though I have not bere access to any Ceylon legislation, a labourer under an advance who runs away without working it out can be by law, and constantly is, captured on a warrant and given the option of going to jail or returning to his master to work under him till the contract is up. I know that in Ceylon at least this provision extends to the case of even domestic servants, for I noted a case of the kind wben passing through Colombo tbis year. Now if to please the neo-anarchist, arrangements that have been legal and useful in operation for fully fifty years (Act XIII of 1859 is the Indian law on the subject) are to be upset and tbe planter left to tbe caprices of beings in a rudimentary state of civilisation, it is about time to sound a note of alarm, so tbat all who bear tbe white man's burden may rally to the common cause; for anarchism is of no single nation.

I have dwelt, I fear, too long on tbe political aspect of the question, and bave thus left myself no space for discussing the various interesting

PROBLEMS CONNECTED WITH THE AGRICULTURE,

of the islands. In another letter I hope to give you some particulars as to tbe staple product, cacao, and the prospects of various subsidiary cultures such as rubber, fibre, coffee, &c., all of whicb are being tried on a minor but fairly effective scale; and to add a few notes on the climate and soil as well as the life, European and native, on the immense properties known as rocas—each roca comprising an area equal to half-a-dozen or more ordinary rubber plantations in your part of the world.

II.

St. Thomé, Portuguese West Africa, July 28.

DEAR SIR,—In my last letter I promised you some further notes upon the products, actual and possible, of this rich little colony, along with a few impressions of tbe life upon the *roças* or plantations, and in the towns. But the field turns out wider than anticipated, so much so that a single letter cannot describe the whole ground. With your permission, however, I will try to dispose of it in two or three letters, to follow.

MALARIOUS COLONIES.

Both islands of the colony are highly malarious, at least on their seaboard and among the foothills of the fantastic pile of mountains forming the core of each. Ten or fifteen years ago the city of St. Tbomé, a litter of packing cases and corrugated iron dumped down in a swamp, enjoyed the reputation, according to its own Health Officer, of being the deadliest town of its size in tbe world. Things have improved since then, but it is still true that neither here nor in S. Antonio de Principe can any white child born and bred in their town hope to reach tbe age of puberty. The West African Telegraph Co., whose cable station, a comfortable two storied bungalow, standing on a wind-swept dune well away from the town of St. Thomé, is inhabited by a staff of three or four Englishmen (the only Britishers in the island) find it, so I am told, their sickliest post in Western Africa. The streets of

S. Thomé are now well-paved, and clean-swept daily, and an excellent pipe-water main has superseded the poisonous surface wells of former days; but though there is a fairly large European population, and many substantial houses of the Lisbon type, the tin shanty style of architecture still prevails—neat and regular everywhere, but quite inadequate to the needs of the white resident in the tropics. The reason for it is to be found in the excessive

DEARNESS OF LIVING AND THE DIFFICULTY OF GETTING LABOUR

for work such as the European cannot himself do.

As one goes inland, one finds the climate improve, and the higher elevations are quite healthy—they would be positively bracing were it not for the atmospheric saturation due to forest growth plus the oceanic influences of wind and tide. At Trinidade, a small hillside town only 7 kilometres from the coast, I found a European priest, fresh and ruddy as if he had never left Portugal, who had been resident there for 30 years without a change, and meant to end his days on the little property he had acquired, close by. The upper peaks of the inland cordillera are seldom visible from below, their cap of dense mist rarely lifting. Cultivation goes far up them, but cacao being the staple product of the islands, the *rogas* for the most part occupy the lower (and, therefore, sicklier) levels, the regions above 1,800 feet ceasing to yield the bean in paying quantities. Here coffee takes its place, and a remarkably fine type of coffee it is, too. Portugal and its African colonies practically consume the whole output. Hevea and Castilloa, also Ficus Elastica (the latter with marvellous vigour) grow throughout this zone. Higher up, coffee gives way to cinchona, and cinchona in its turn to *obó* or primeval forest, a labyrinth of timber trees, laden with epiphytes and densely interwoven with creepers, the most notable of which are a stem-clasping Ficus known as *lemba-lemba* and a Landolphia—the L. Dawei, yielding caoutchouc. Vestiges of this forest are to be found throughout the plantations below, the giant *ocá* (Eriodendron anfractuosum) and the equally colossal *amoreira* (chlorophora excelsa) being conspicuous in the cultivated area, the former by its huge buttressed trunk, naked and grey, with triple or quadruple crown formed by horizontal tier upon tier of branches, the latter by its brownish cylindrical column, towering some 80 or 90 feet in the air before throwing out a single branch. Beneath these, the

CACAO, MANGO, AND BANANA

plantations appear dwarfed to the proportions of an insignificant scrub jungle. The virgin forest runs up to the very tops of the mountains, except where these culminate, as they often do, in conical peaks or cliffs of basalt affording a foothold to patches of herbaceous vegetation alone. These basaltic monoliths are indeed a feature of the islands, down to the coast, one of them, known as *Cão Grande* ("Big Dog") rising sheer up to a height of 1,000 feet from its base; a single stone obelisk, higher than the Eiffel Tower! Its pedestal alone stands nearly 1,000 feet from sea level. Thus the islands are rich both in quarrying stone and in timber, some of their woods being extremely valuable, while there is no lack of fuel, thanks in part to Nature, and also to the management of the upper forests by the proprietors, so far conserving unchanged, despite the claims of cultivation, the characteristics of the island soil and climate.

Cacao-growing in these islands, complicated as the question is with that of labour (the coffee plantations, being mostly older, have their permanent labour establishments of negroes born and bred on the estate, and being replenished by the children of these, they are independent of importations from the African Continent), would require a volume to itself, and I hope ere long to be in possession of sufficient data to do this aspect of it the justice it demands. For the present suffice it to say that the campaign against the Portuguese product, initiated or rather resuscitated by the sect of whose impracticable doctrines Messrs Nevinson and Burt are the leading exponents, is reported to have had at least one unexpected and amusing effect. A prejudice against

"SLAVE COCOA"

—a question-begging term extended later on to the chocolate confectionery of Messrs Cadbury as known buyers of S. Thomé cacao—having been created, or alleged to exist, in the British public mind, that firm, for their own good name quite as much as for the protection of their industry, found themselves compelled to pass on to the planters of S. Thomé and Principe the pressure with which they were menaced. The Great British public, to quote George Eliot from memory, reserves to itself the utmost right of private haziness; and in all probability few of the good folk who caught up the cry of "a slave cocoa" could say where S. Thomé was, to whom it belonged, or what were the provisions of law said to sanction this "modern slavery." But, slavery or no slavery, a healthy appetite can generally be trusted to hold its own against a sickly sentiment. The Great British palate had acquired a liking for the grateful and comforting beverage and the dainty sweet, into the composition of which the Portuguese bean so largely entered. No new cacao could quite give the accustomed flavour. So, Britain's need being, as it ever was, Germany's opportunity, our Teutonic cousins set to work to buy up the stock, and now the good old "slave cocoa" goes to Hamburg, whence, labelled "made in Germany," it is unloaded on the British market for the consumption of the conscientious objector.

Be this as it may (I have it from a Hamburg merchant now in S. Thomé who presumably knows what he is talking about), the story is a digression from what I was about to tell you of cacao cultivation. To resume:

THE VARIETY

most commonly grown in the islands is that known locally as *crioullo de S. Thomé*—not to be confounded with the *criollo* of Trinidad and Venezuela. which has also been introduced, along with the purple and yellow forms of the *forastero* group. According to M Aug. Chevalier, an eminent French botanist whose monograph on West African cacao is a standard work, the *crioullo* cacao of S. Thomé exhibits capsules of both colours. The S. Thomé planters, however, say he is wrong on this point; the original *crioullo* type of these islands, a fixed type, being

yellow alone. The point is an interesting one, both botanically and etymologically. The Spanish term *criollo*, of which *crioullo* and *creole* are the Portuguese and French-English variants, in the strict sense denotes an individual of pure white race—*not* mixed—born and bred in a tropical country, as distinguished on the one hand from the coloured man, and on the other from the non-domiciled foreigner—the *forastero*—of the same race. By extension to the vegetable kingdom, with application, in the special case in hand, to the cacao plant, *criollo* and *forastero* (and their cognate forms in Portuguese) serve to designate fully acclimatised and newly introduced varieties respectively. But as acclimatisation, both in the animal and the vegetable kingdom, brings with it an assimilation to the indigenous type or at least to that already modified and adapted to its environment, the term *forastero* in the course of a generation or two ceases to indicate more than a historical distinction. And this is specially true of cacao cultivation in S. Thomé. The history of its early introduction is a matter of dispute. It is quite certain that in 1822 a stock of cacao imported from Bahia, Brazil being then a Portuguese colony, was successfully raised on the Agua-Izé estates—to this day the most important property in the islands. Also that the *crioullo de S. Thomé* is the type universal on the Gold Coast, in the French Congo and the German colony of Kamerun. It is equally certain that a consignment of *forastero* (in which term must be included the foreign *criollo* varieties of Trinidad and Venezuela) was received in this island in 1882—sixty years later than the first supply. Its succeeded perfectly, but is still undergoing the modification imposed by the law of adaptation to environment. Chevalier, however, while admitting all this, doubts the 1822 importation having been the source of the staple *crioullo* of the islands. He sets it much further back, and inclines to the belief that the plant was imported from the Spanish main in the 16th or 17th century, acclimatised in Fernando Pó, and distributed thence to St. Thomé and Principe on the one hand, and to the African coast settlements around the Gulf of Guinea on the other. As to the so-called *crioullo de S. Thomé*, he not only maintains that it exists in the purple-capsuled variety as well as the yellow, but that the former is the more resistent, the latter only forming 1-5th of the total visible on the trees planted at the higher levels (about 700 metres above sea-level.) The planters' reply to this is that M. Chevalier has misinterpreted the phenomenon he describes. What he has seen is not a purple *crioullo*, but a purple *forastero* (which at those elevations *is* more resistent) in process of modification—at a stage when the shape of the capsule, but not yet its colour, has assimilated itself to that of the *crioullo*. Had he pursued this line of investigation at the lower elevations, he could hardly have failed to note the further process of adaptation to environment, as presented by trees bearing on the same stem fruits of all shades intermediate between purple and yellow, the tendency being to the extinction, more rapidly at lower (and more suitable) elevations, less so at higher, of the purple variety; this being the final stage in the general assimilation of the more recent importations to the established type.

Peculiar to S. Thomé and Principe, distinct both from the original *crioullo* and the more recent *forasteros*, is a cacao of unknown origin, which Chevalier, failing to discover any link between them and it, has raised to the rank of a species under the title

THEOBROMA SPHAEROCARPA.

This tree is very prolific, bearing a fruit of the shape colour and size of a Malta orange, but ribbed like any other. Popular name, cacao laranja. It does not seem to have been described elsewhere. The planters remember it as abundant for more than a quarter of a century, but do not agree as to its value, some condemning it as likely to lower the standard of the island cacao, its bean being small and bitter. Senhor de Mendonça, proprietor of Boa Entrada, one of the larger estates in St. Thomé, tells me that all the trees he has of this species have sprung from the seeds of a single capsule, brought from Principe eighteen years ago; and the better he treated the seedlings the worse they repaid him, so that practically only those planted out in the jungle from the first and left entirely to nature gave any satisfactory results. Chevalier on the other hand notes with approval the opinion of those planters who hold that in good soil and with due care the crop can be vastly improved. But after an exhaustive examination of the bean, he concludes that though with pulp attached it accounts for from 23 per cent to 27 per cent of the total weight of the capsule, its abundance does not make up for its smallness in size. He accordingly classifies it as a second grade cacao.

Whatever the variety selected for reproduction, the seeds are chosen with the utmost care, it being usual to set apart the most promising pods and to limit the beans for sowing to fifteen or twenty taken from the centre of the pod These are at once sown in rich soil previously prepared, generally in baskets in a nursery, but sometimes directly in the pits *in situ*. In either case the pits in the plantation have been dug months beforehand to a depth length and breadth of a cubic metre at least, all possible stones being removed, and the hole half filled with dead leaves and rotted capsules, to be covered later on with earth up to the level of the ground. If the sowing is direct, as many as ten seeds may be placed in the same pit, or three seedlings if the planting out is done from the nursery. The two or three best seedlings of the lot are, as a rule, left to spring up together, forming clumps the individual trees of which are noted by Chevalier to be fully as vigorous as if planted out singly. The season of year selected for sowing is generally the beginning of the rains—October or November—but it has been proposed to gain a year in the growth by putting out the seedlings in dry weather, when the labourers are not so liable to be hustled by the heavy showers, and the European supervisors to malarious influences, most prevalent at the commencement of the wet weather,

DISTANCE FOR PLANTING.

Theoretically, the trees are supposed to be planted at 3 or 4 metres apart, but practically, even in the best European plantations, no serious attempt is made at alignment, while in the native plantations as many as five or six trees may be found standing on a single square metre. The reason is obvious. The soil is full of boulders of all sizes and where there are so large as to requiro explosives for their removal it is cheaper to let them remain and dig the pits in the nearest soft soil. Such stones as can be romoved by hand are taken out and piled up elsewhere for use in road-making or as ballast for the lines of Decauville railway with which most plantations are provided. The Negro has even less conception of a straight line or a right angle than the Tamil cooly, and even were it to be marked out for him, the mortality among the young plants and the undesirability of replanting on the exact site of a dead tree would in the course of two or three years destroy any symmetry given to the plantation at the outset. So things are left to rule of thumb in this respect.

WEEDING.

The weeding of the plantations is, however, too important a matter to be left to Negro caprice. In the drier portions of the islands (for, small as they are, climatic variations exist), all undergrowth is carefully cleaned up twice a year, and olsewhere not less than thrice. Apart from its value as a cultural operation, it is interesting to note how the Portuguese in the island of Principe have turned these repeated weedings to account in their defensive warfare against an insect pest much more formidable to the planting community. European and African alike, than even its congener the pseudo-humanitarian microbe; to wit, the *glossina palpalis* or tse-tse fly—the agency by which the microbe of

SLEEPING SICKNESS

is transmitted to the human subject. This fly is unknown in S. Thomé, but has existed in Principe longer than the memory of the oldest inhabitant—not, however, to the appalling extent recorded in the African interior. Senhor Maldonado, managing director of one of the large properties in that island, having noticed that the Negroes attacked by the fly were almost invariably stung in the back and shoulders, the portions of the body most exposed while stooping to weed under the trees, set himself to study the case and puzzle out a remedy. He noticed that the fly made a practice of sheltering itself under the leaves of the cacao or banana, also that it showed a decided preference for dark-coloured objects, avoiding the white clothing of the European as it avoided direct sunlight. Putting these facts together, Mr Maldonado issued black cotton coats to his men, and made them smear them outside with the sticky latex of various jungle creepers abundant in the island before putting them on. He ordered these garments to be worn throughout all operations entailing the stooping attitude. The oxperiment was perfectly successful, large numbers of the fly being thus destroyed. When reported to the Board in Lisbon, its value was at once recognised, and arrangements made for its working on a large scale; record being made of the results. By the end of the year Mr Maldonado was able to report 28.692 *glossinas* trapped and destroyed on his estate alone, while the neighbouring estates accounted for no less than 133,778 in the same period. The practice is now general throughout the island, and the Medical Commission of three specialists at present engaged in the further study of the disease are able to record substantial progress in the prevention if not in the cure of this terrible malady.

This noto has, I regret to find, exceeded the limits I had set it, the enemies of the planter having overflowed into the space I had hoped to reserve for the enemies of the plant. My next must occupy itself with these, and then with the processes of harvesting and preparation for the market.

(*To be Concluded.*)

RUBBER LAND IN B. N. BORNEO.

The Chief Government Surveyor in the course of a report on a visit to the West Coast in search of land suitable for rubber planting writes :—

I also examined land directly behind Jesselton at a distance of say 2 miles, the greater part of which distance has already a good road ; this land is of a very open nature, being rough grass and scrub with very littlo roal jungle, but is excellent and, though somewhat cut up with swampy valleys, mostly drainablo, would I think make a very excellent rubber estate of about 1,500 acres ; its nearness to Jesselton should be a very great inducement to any small company to at once start operations.—*B. N. B. Herald*, Sept. 1.

JAPANESE CAMPHOR EXPORTS.

On Japanese Camphor Exports some interesting details are given by Paul Martell in *Chem. Ind.* (Berlin), from which it would appear that Germany, in consequence of her large celluloid industry, is the largest purchaser of this stearoptene. Thus, whereas the total exports of camphor from Formosa and Kobe in 1904 were 55,442 piculs, Germany took 10,134 metric centners, value M.4,560,000 ; in 1905 were 45,277 piculs, Germany took 8,902 metric centners, value M.5,786,000 ; in 1906 were 48,339 piculs, Germany took 8,829 metric centners, value M.7,206,000. After Germany follow, in order of importance, the United States, India, England, France. Japan's production of celluloid (which product was formerly derived chiefly from Germany) has grown in importance since the founding of the Aboshi works by a syndicate of English, German and Japanese capitalists, and this will naturally influence the camphor market. In order to protect the camphor monopoly, which had suffered from the fact that high prices of recent years had stimulated the development in synthetic processes, the Japanese Government has determined to increase their productive capacity to the fullest extent. With this object in view they have had no fewer than 6½ million camphor trees planted in Formosa and Shikoku. It must be remembered, however, that the trees have to reach the age of about 100 years before their camphor production becomes important.—*British and Colonial Druggist*, Sept. 3.

NEW DISEASES OF RUBBER.

ADDRESS BY THE GOVERNMENT MYCOLOGIST: BEFORE THE KELANI VALLEY PLANTERS' ASSOCIATION.

The CHAIRMAN:—Gentlemen, I have now the greatest pleasure in introducing Mr Petch, who has kindly consented to come down and give a lecture on diseases of rubber trees. (Loud applause.)

After a short interval for refreshments, Mr Petch began his lecture, during which quite a number of specimens of stem and root diseases were exhibited and the diseases explained.

Mr T PETCH—addressing the meeting, said: —Mr Chairman, and gentlemen,—I think the Secretary has sent round a circular, the latest one, on Hevea disease, "pink disease," of which you have got so many specimens in this room. It is distinguished by a pink coating on the outside of the bark. When it is there it kills the bark and ruins your tree. It becomes yellowish when old. That disease was called the "writing fungus" in the Straits because it breaks up into fragments like Sanskrit or something of that sort. If it is wet, it may be whiter than this; it is fairly pink here, but it is nearly white on this side. (Specimen shown.) If you have any doubt when you see what you think is the fungus on your tree cut out the bark and send it for report.

Mr SCOTT:—Does it kill the tree?

Mr PETCH:—It kills the bark of the tree; but if it rings the tree far enough,

THEN THE TREE DIES.

If it comes on one side, it will not kill the tree. There is another case here (specimen shown) where it developed on one side of the branch. The other lateral branch is not dead, but above it it has died off. You will find the "pink disease" here below. Here is another specimen. It usually starts near the top of the tree so that if you cut off the diseased top the tree will go on growing. But in this case the disease has been allowed to come down the tree. This part below is quite sound. So that if you cut off there, you will save the rest of the tree which will sprout from below.

Mr. BONTOR:—Is that the same disease you referred to before?

Mr. PETCH:—Yes. The easiest name to remember it by is "pink disease," because there is a pink colour outside. The only additional fact beyond what has appeared in the circular is that

THE DISEASE WILL GROW ON CROTALARIA.

If you plant up Crotalaria in Rubber and let it grow for a year, or a year-and-a-half, you will then get more of the pink disease on the Crotalaria than you would get it on your Rubber. In fact, your Crotalaria will serve as a source of disease for your Rubber. They are finding that out in South India, where they planted their plantations with Crotalaria and let it grow for nine months before it flowered and got a fairly good stem like this (shown.) The whole of the stem gets attacked in the South West Monsoon with this disease and from that Crotalaria it spreads to the rubber. In some places in South India they have Rubber two years old in the field and as soon as it is of that age it is attacked by the "pink disease." In some of their fields at present they cannot get a stem more than two years old.

Mr DUNCAN:—Do you get it from the jungle?

Mr PETCH:—You will find most of the spores blown out of the jungle. The disease flourishes most in wet weather, and during that time the spores are blown out from the jungle and infect your trees. Now we will leave that disease and go on to the next, about which nothing has been written yet—the chief disease which is awaiting a circular, which we hope to get out in a week or two, and that is what is known as

THE "DIE BACK" DISEASE.

The trees usually attacked are about two years old but this year it is found on trees from four to nine years of age. The name supplies you with the nature of the disease—the branches attacked "die back" from the top shoot and the disease works itself down to the base. Unfortunately that does not distinguish it from anything else. Your leading shoot may die back from many causes apart from the disease, as for instance, wind, damage by rain, shade, or over-tapping. If you get the root disease, too, the tree dies back. The chief feature in the "die back" disease is that the top shoot dies back while the rest of the tree is green. In the case of root disease generally the tree dies back all through at the same time. Then in the case of leaf disease generally the leaves fall all over the tree; but in the case of the "die back" disease you get it from the top shoot which gradually dies off—and if it is not cut off, and the disease checked, the dying off process continues and the section just below succumbs next. If you cut it off below, the rest of the tree will flourish, but if you neglect to do so the tree will further die back till the disease reaches the base and the tree is killed out-right. (Position demonstrated on black-board.) You have practically to watch it going on. Of course

YOU CAN CUT IT OFF

if you see the top shoot attacked. Here we have an example (shown) where the tree has died back to a certain stage below which you get fresh shoots. Here is another case where the disease has gone right down the stem to the base, while three branches at the top are green. The disease may come straight down the stem and leave some branches near the top green. In this case it is dead low. You can get the whole tree killed in a month. (Laughter and cries of "Oh oh.") You may confuse it with root disease or general leaf fall, but in those cases the tree will not be green, while in the case of the pink disease referred to, it will show itself in colour. It is a simple thing to determine. Remove the earth from the base of the tree and you will see, if the top dies and you are not sure, whether it is the root disease. If any fresh shoots arise it is "die back" disease, but if they do not, it is root disease. If you lop off the trees that die back they will thrive without any ill effect. This is the first stage, the beginning of the "die back" (specimen shown). The shoot turns brown and soft; and here, a later stage, it becomes hard and grey. The fungus, however, does not attack the stem in which the wood is already formed. But after the death of the leading shoot another fungus secures a footing and carries on the destruction right to the base of the tree, and the tree is killed off. The

CHIEF OF THESE SECONDARY FUNGI

forms black patches on the bark of Hevea. If you cut down a tree and leave it for a week or so, it gets covered with this fungus. In the case of the branch killed by "die back" this black fungus (Diplodia) settles down and kills the rest of the tree. That makes it difficult to tell when you send us the top of a tree, all the way to Peradeniya, whether it had died of "die back" or root disease, as it gets affected with this secondary growth of fungi. If you do not send the whole tree, it is practically impossible to tell what disease has affected any particular portion because by the time the branch or section gets to Peradeniya it has got a host of Diplodia. You will find that between the bark and wood is black as coal. If you scrape the bark a little, you will find black spots which are full of spores. The best way to deal with "die back" is to cut off the branch before the tree is killed right off to the base. The dead top and green lower branches are absolutely distinctive. There has been rather an outcry in other districts, not much in the Kelani Valley, that all the trees are dying back. In August-September they all wondered, in the Kalutara and other districts, at the

LEAVES COMING OFF THE TREES.

Mr. DUNCAN:—You mean, to say that the trees get bare?

Mr. PETCH:—In some cases they get absolutely bare. In some cases the leaves have dropped from the South-West side; and in other cases there has been a general thinning out. In the Kalutara district there are as many leaves on the ground as in the Wintering season. This is not "die back." It is easily distinguishable from the other because it occurs all over the tree—both top and lower branches cast their leaves at the same time. People send dead branches out of such trees to Peradeniya, and when we look into them we find that those dead branches were not killed by disease. These dead branches must have been there for years: they had been killed by shade. As soon as the dry weather sets in these leafless branches break out into leaf. I went through that leaf fall and could not find any fungi. The last attack was in 1903 and 1909 (August.) If you study the rainfall of 1903 and 1909, you will find that the conditions were the same in the two years. You had rainfall in August, 1903, just about equal to the rainfall of August, 1909. If you had any general leaf fall in your trees, it would be rather interesting to look at your rainfall and see whether that works out correctly, that is if you were working at your Rubber from 1903 to 1909. Many trees shed their leaves abnormally in wet weather, that is, in periods wetter than they are accustomed to. Some of them will shed their leaves when you have a hard pan,

A SUBSTRATUM OF ROCK;

others when they are grown on too sodden ground. There is much in the case of Hevea that we do not know.

Mr G H MASEFIELD:—Will that rocky pan account for a portion of the trees shedding their leaves on a plantation?

Mr PETCH:—That is a matter which upsets the idea that shedding is due to rainfall. Your trees may defoliate in groups.

Mr BAINES:—It has a good deal to do with want of rain.

Mr PETCH:—It has a good deal to do with rain because the worst places are both windy and rainy. The worst places I have seen were in the South-West wind with 180 inches of rain this year. I mention all this because a good many people have got frightened about leaf fall, and a paragraph in a paper told us about a new disease of rubber appearing in various districts. That is chiefly what happened. It was entirely due to wet weather, and as far as we can find out no fungus whatever was associated with the falling leaves. The next thing which has been brought out by the wet weather this year but not in this district—we had some of it last year too but it was not noticed—is the

OLD CANKER DISEASE OF 1903—04

which was supposed to have vanished. In fact, last year, I wrote that I could not find a case of canker when I wanted to see it. But this year there is a lot of it but not in the same form as in 1903. In 1903 it was found usually on the untapped bark; and if you read the Peradeniya circular of 1904, you will find that the disease was distinguished by the bark becoming a sort of dirty claret colour underneath, where it went right into the wood. This year it started on the renewed bark (specimen shown). The first thing observed is a series of small vertical lines on the renewed surface. In most cases the bark seems to sink round these lines so that you get a sunken patch vertically. If you cut that out, you will find the bark dead and the cambium blackened. If you go on cutting where you do not see the black lines, you will find spots on the cambium. As a rule it works upwards, but does not go very far downwards. It is rather peculiar that you can go on

TAPPING THE WHOLE TIME WITH THE DISEASE ON.

If you go on tapping as you do, once in two days, you can go on with the tapping work faster than the canker works. It does not kill the trees.

WHEN THE DRY WEATHER COMES, IT STOPS;

and there is no more infection in such weather. This specimen (shown) had one renewed surface in dry weather and another in wet weather. This renewal is perfect; but the renewal in the wet period is all canker. It does not spread far, at any rate in this specimen it has not. So all you have to show for the canker period is this one strip of dead bark which is renewing already underneath from the healthy bark. As far as the tree is concerned, it is healthy in effect and the crop is not affected, but the difficulty comes here—the bark over these cankered parts will be rough. Instead of the renewal coming up regularly under the bark it is coming round holes where the canker is there. This (specimen shown) has not got far enough in renewal, but in some of the Kalutara places where they are tapping on a 3 months' system—3 months here and 3 on the other side—you can trace it back to eighteen months wet and dry weather

periods. The dry weather period is smooth and in the wet weather the tapping is rough. The bark is up and down. It has been injured by the canker. This renewal of bark over the diseased portion

WILL SPOIL YOUR ESTIMATES.

Are you going to restrict your tapping to the dry weather period in order to provide a smooth renewed bark?

Mr MARTIN:—Is any permanent injury done?

Mr PETCH:—The permanent injury done is that the renewed surface is rough.

Mr BAMFORTH:—Is that all?

Mr PETCH:—That is the biggest *all* (laughter). That is the biggest question with regard to the Rubber Industry at the present time. You get trees tapped, say, the first round in four years. Some of them will have smooth bark, but some, especially if canker is present, will be rough, and you cannot tap that with an ordinary knife. You may do it with another system.

Mr BAINES:—You can tap it with the present knife?

Mr PETCH:—You cannot; and this will make a big difference in the estimates, where you have a hundred trees or so rough barked. When you go to tap your trees the second time you will find you cannot do it with the ordinary system; and probably where you came back the third time you would find a few more trees rough-barked. The number is ever increasing; and how long can you go on?

Mr MASEFIELD:—Has this particular kind of canker appeared in the Matale-Kurunegala districts.

Mr PETCH:—I have not had any canker from tapping from Matale. But it is all over the low-country districts. The time will come ultimately when you will have 50 per cent. of your trees rough barked; then you

WILL HAVE TO ADOPT ANOTHER SYSTEM OF TAPPING.

The obvious thing is to make your first bark last as long as possible.

Mr MITCHELL:—Otherwise do not tap in wet weather.

Mr PETCH:—No; that won't meet the difficulty.

Mr WILLIAMSON:—You have a new system?

Mr PETCH:—When I have a

NEW SYSTEM I WILL SELL IT.

(Laughter.) The rough bark is in a small percentage, but it is actually happening. There are a good many rough barked trees in your second tapping, but you can hack and collect the scrap.

Mr KYNASTON:—Though the bark is rough, you can tap.

Mr PETCH:—That is a question for you to decide. It has been suggested that this canker, as it comes on only in wet weather, is due to rain lodging in cuts. The things we get out of it in the laboratory are just the same as we got out from the canker of 1903. If you take a section of a tree and examine it in the proper way you will first

GET A LARGE QUANTITY OF BACTERIA,

and the second organism will be the *nectria* fungus. I have bacteria grown in beef tea and other media and got the *nectria* spores to germinate and grow in solutions and made inoculations of trees at Peradeniya with pure cultures of the bacteria and the *nectria*. This was done three weeks ago and up to the present there have been no signs whether they are going to have canker. So we cannot say yet whether it is due to the rain getting in—whether that is the most likely cause—or the organisms getting in. I think it is due to the bacteria getting in. Of course, the old advice to deal with the canker is to cut out all the dead bark. You will probably get a smoother renewal if you cut out your decayed bark than if you leave the old bark to renew itself. There is no need to stop tapping because of the canker, as you can get the latex with the disease present. You can go on tapping the whole time. I am inclined to say: cut out the diseased bark, and

STERILISE ALL YOUR TAPPING TOOLS.

As far as we can see—on some estates I have been to—you carry the infection from one tree to another by the tapping knife. If you only get one cankered tree or two, the best thing to do is to leave those trees alone. But when you have 50 per cent of the trees affected, it is impossible to leave them alone. Sterilising the tapping knife is easily done by dipping it in one part to 1,000 of corrosive sublimate and leaving it there 5 minutes, which is ample. That will kill any bacteria on the knives, but it will only be effective where you start tapping on a new clearing. If you sterilise your knives and go on to infected trees next day your sterilising will be of no avail. On the whole it is rather difficult to know what to advise in a case of canker. Certainly I will not advise to stop tapping. (Laughter.)

Mr MASEFIELD:—With regard to the treatment of canker will you put tar on or leave it alone?

Mr PETCH:—No; do not; leave it alone.

Mr MASEFIELD:—Will you cut it out?

Mr PETCH:—If you cut out you must remove everything that is black. The specimen here (shown) shows black round the cambium. I would not cut into the wood. There is

NO NEED TO HACK INTO THE WOOD.

It is a question of judgment as to what you would cut out and what you would leavo alone.

Mr BAMFORTH:—Is there any danger of the canker spreading? It is better to leave the tree alone or cut it out!

Mr PETCH:—Certainly leave the tree alone, but it all depends on the number of trees you have got. (Laughter.) If you have two or three cankered trees, you should leave them

OUT OF THE TAPPING ROUND.

You could cut out the diseased bark and leave the trees out of the tapping round. Even if you do not cut out the diseased bark, I do not think you will spread the infection if the trees are left alone. I am pretty certain that infection is carried, say from one cankered tree you have, by the cooly who taps that and goes on to the next. You find the cankered trees spreading gradually down the line from the first diseased tree.

Mr MARTIN:—Will it cease to spread if you stop tapping on that side?

Mr Petch :—Certainly, Only before I started on the other side I would sterilise every tapping knife

Mr MASEFIELD :—When you cut out this diseased section, you do not recommend tarring or treating it in any other way?

Mr PETCH :—I would not tar the surface in a case like this. I would always tar where you cut off the branch of a tree. If you simply take off the bark, there is no need to tar because the spread of the bark is more vigorous.

Mr CANTLAY :—Can you suggest anything else instead of tar?

Mr PETCH :—Tar prevents the decay of wood; and it is a splendid waterproof protection. Fungi cannot get through it. I do not think you can look to anything better than coal tar to apply to a cut.

Mr WOOD :—The disease does not pass from tree to tree unless it is carried by the tapping knife which is not sterilised.

Mr PETCH :—It

CAN BLOW OFF,

but it is chiefly spread by means of the knife.

Mr WILLIAMSON :—You think it is a mistake to lop big trees on the estate to save your tea?

Mr PETCH :—It is a mistake unless you tar the ends of the branches lopped off. Lopping and taking off the leaves will also rather spoil the feeding capacity of the tree. As long as you tar the lopped ends you are safe. Coal tar, of course. We had a very good example in 1904. In that year two of the Government plantations were treated for canker. In a large number of cases the trees were stumped, and in some cases they were cut off at a fork. Fungi have now attacked the cut surface. The heart wood of any tree is just as good as dead, and where it has been exposed, fungi have entered the trees and they have snapped off.

Mr. DUNCAN :—Cutting of branches is not an ordinary matter.

Mr. PETCH :—Why not?

Mr. DUNCAN :—The plants are too old.

Mr. PETCH :—If they are more than 2 inches in diameter I will always tar. There is another example we had of

STUMPING TREES

about twelve years old which were in the way of a road which was to be made through a plantation. The Superintendent took off the trees, cut off the tops and transplanted them. In one case out of five of the branches forking from the main stem only four were tarred at the lopped ends for some reason or other, and the fifth left untarred. The four tarred branches were all right, but the fifth untarred one commenced to die back one foot within a year; and if that is not cut, and the surface tarred, it will die back until it enters right into the tree and the whole will collapse.

Mr. BAMFORTH :—Lopping does not stop the flow of latex?

Mr. PETCH :—I do not think so, unless you lose the latex you would have got from the lopped-off branch. Lopping will stop the growth of the tree to some extent. The tree will not grow as rapidly as before and therefore you will get a smaller quantity of latex.

Mr. CANTLAY :—What about fungi spreading from the dead tree to the living ones?

Mr. PETCH :—The fungi could not get in at the end of the tarred branch.

Mr. WOOD :—If you leave a

FALLEN TREE LYING ON THE GROUND,

what will happen?

Mr. PETCH :—You will first of all hatch out the "die back" fungus and secondly root disease. So much has been written about the root disease that there is no necessity to go into it now. This is the well-known "Brown Root Disease" which is easily identified by its habit of cementing sand, soil, and stones to the roots of the trees attacked.

Mr. BAMFORTH :—After cutting off, you must burn the cuttings?

Mr. PETCH :—If you cut off the "die back" or "pink disease," you must burn the portions cut of, instead of leaving them on the ground.

Mr. MASEFIELD :—As regards Stockholm tar, will it not answer in the case of treating the cut off surfaces?

Mr. PETCH :—Stockholm tar is a vegetable tar, and I do not know if it will answer for canker.

Mr. MASEFIELD :—It is a mistaken idea among planters that Stockholm tar has to be used.

Mr, PETCH :—Coal tar, of course, is the tar to be used. The difficulty comes in the case of tea. What was found suitable in the case of tea was sought to be made applicable in all cases. If you tar the growing bark of tea with coal tar it will kill that bark; if you tar cut ends, it will not kill. Some 15 or 20 years ago somebody

SCATTERED COAL TAR ALL OVER HIS TEA

bush and found it was bad for it, and that idea continues to the present day. (Laughter.) There is no reason why you should not use coal tar, which is very much better than Stockholm tar.

Mr. CANTLAY :—In this case (specimen shown) the canker came on after you resumed tapping in the wet weather?

Mr. PETCH :—You can have canker on the untapped. In the present year it is coming on more in the tapped area.

The CHAIRMAN :—Mr. Petch has finished his address and we have now to return him a hearty vote of thanks.

PRICKING AND TAPPING.

Mr DUNCAN—with the permission of the Chairman—asked another question or two. Mr Petch had written a rather interesting paper on tapping; he wished for information with regard to the use of the pricker and the tapping knife.

Mr PETCH—said that he could only tell Mr Duncan to go on experimenting with the systems. He instanced the case of a gentleman in Ceylon who was very strong on the use of the pricker, but he had not used the pricker, after trying it, on the estate in his charge the last two years. (Laughter.)

Mr DUNCAN—remarked that Mr Petch's statement had been that renewed bark under the pricker did not carry latex cells, that, given plenty of pricking, it would stop the development of latex entirely.

Mr PETCH :—There is a qualification to that. We have examined renewed bark under the pricker marks up to an age of six months, and from what we have gathered in the first six months your conclusion is practically correct—

that is, if you go on pricking you will come to a time of no latex. But the tree may go back to its old habit again probably in 1½ years. You have impressed upon it with the pricker a production of bark which is not laticiferous.

Mr. DUNCAN :—It will be only four years.

Mr. PETCH :—It will turn your four years into five-and-a-half years. You mention four years because you are going back to your renewed bark in four years. If it takes one-and-a-half years for the bark to revert to its original habit, you have five-and-ahalf years.

ABOUT BARREN TREES.

Mr BAINES :—Have you met any barren trees lately? (Laughter.).

Mr PETCH :—Lately, no. I have never met a tree which has never given latex.

Mr BAINES :—I have a tree which gave latex and then went back.

Mr WILLIAMSON :—Struck by lightning, I suppose. (Laughter.)

Mr BAINES :—The tree was perfectly all right with the bark thick and strong; but I could not get anything out of it.

Mr BAMFORTH :—We have to thank Mr Petch very much indeed for his interesting remarks. (Loud applause.)

This brought the proceedings to a close.

RUBBER NOTES, &c. FROM NATAL.

(By a Ceylon resident in Durban.)

THE ONLY INDIGENOUS RUBBER-PRODUCING SPECIES

of South Africa at present of any concern is *Landolphia Kirkii*. It is a *liane* growing in the northern countries of Zululand, *i.e.*, Maputaland and Amatongaland. Although it may be met with rarely, it is said not to be found further south, but extends northwards into E. and W. Tropical Africa. I believe this plant, with perhaps one or two of its congeners, yields most, if not all, the rubber at present exported from these regions. *L. Kirkii* is commonly known as the Rubber Vine. About six years ago the Natal Government had an officer in Maputaland reporting on the possibilities of exploiting the Rubber Vine on an industrial basis. Samples of Landolphia rubber were sent to England and favourably reported upon. This was followed later by the leasing of a large area in Maputaland to a Natal Syndicate. I know that some shipments were made, but since then there has apparently been no development, and I suspect the venture has come to a standstill. Although the quality of the rubber has been declared good, Maputaland has a deadly climate and labour is scarce and expensive. The Directors of the Syndicate approached me with a proposal to sever my connection with Government and accept service under them: but the disadvantages were so obvious that I did not even discuss the matter with them, and from what I have since learnt from private sources I have reason to believe that my decision was a wise one.

That is all there has been done with rubber as a commercial speculation in South Africa. I think, however, when we have tided over our present depression and capital is available, that interest in the subject will be resumed in Natal and Zululand. At present there is a

PLANTATION OF THE RUBBER VINE IN THE GOVERNMENT EXPERIMENT STATION AT EMPANGENI

in Zululand; the experiment is being watched. As a *liane* Landophlia is difficult to manage under cultivation, and we shall probably have to turn our attention to exotics and with the selection of a species suitable to our comparatively dry climate the problem might be solved. There are fine specimens of the India rubber or Assam rubber (*Ficus Elastica*) growing in Durban and extending inland as far as Maritzburg and I am told southward, even to Capetown. But I much suspect that the climate is too dry to induce a sufficient flow of latex. For the same reason Para rubber, though it grows in Durban, would also fail on a large scale. The most likely species to succeed is, I think, the

CEARA

rubbers—Manihots, which are fast growers and are amenable to dry conditions. Plants of *C. Glaziovii* do well in Durban and seed freely. Will you please furnish me with the names of the new varieties of Ceara which, I understand, you are adopting for the dry districts of Ceylon. Naturally they are of great interest to us. I am sending you an illustrated souvenir of Durban which will give you a fairly comprehensive idea of what the largest,

FAIREST AND HEALTHIEST TOWN

in Natal is like, especially during the winter gala season. The winter here is, however, not like what it is in England, since Durban has a sub-tropical climate. The heat is trying in summer, but in winter the weather is as nice as you can wish it to be. As you drive round the city in a car you will be surprised to find old Ceylon friends like *Bougainvillea*, *Aleurites triloba*, *Poinciana regia*, *Hibiscus tiliaceus* luxuriating here.

There is only one Agricultural College in Natal at the Central

EXPERIMENT STATION AT CEDARA

near Maritzburg. When I first joined the Department I was there for five months on the Forestry Staff. Beside the central station at Cedara, there are branch experiment stations distributed about the colony; and students from Cedara are drafted out during the course of their learning to one or more of these stations for a brief period. While agriculture, including stock farming, dairying, etc., is what is principally taught the students, a brief course in Forestry —or strictly speaking, in the formation and tending of plantations of exotics—forms an incident in the curriculum. The object is to

ENABLE THE PRIVATE FARMER TO INTELLIGENTLY CO-OPERATE

with the Government in increasing the percentage of forest-clad land—a consummation devoutly to be wished for more reasons than one.

The policy in the College is to give the students nothing but technical instruction and there is no chance of their qualifying to be anything but farmers. They ultimately take up their own lands or manage or work upon a farm. The instruction is almost entirely practical. The stu-

dents have to use their hands and work hard. A great deal of their time is spent in the field where they learn the handling of implements, livestock, &c. The fees paid are not high, but this is compensated for by the actual work put in by the students.

There is a Government institution here known as the

LAND BANK FOR PROVIDING LOANS TO FARMERS,

for the improvement of their farms. I believe it originated in the time of Sir Henry McCallum, but am not sure. I wish your Governor's schemes for agricultural education, &c., all success, I hope the native cultivator has of late imbibed some progressive ideas since I knew him. Otherwise it will be hard and slow work.

THE NEW RUBBER COAGULANT.

Of Mr. Aubrey Elias.

In our issue of August 20 we published some particulars of a chemical reagent which will, according to the claim made by the discoverer of the process, Mr O Aubrey Elias, F.C.S., quickly and effectually coagulate rubber milk without imparting any deleterious effect to the finished product. In support of Mr Elias's claim, Mr C T Gardner, dispenser at the Miller General Hospital, Greenwich, has given to the public the result of his analysis of specimens of rubber treated under the new process, Mr Gardner has also given particulars to a representative of the Press Association, and these were recently set forth in the *Financial Times*. It is the

SCIENTIFIC ASPECT OF THE DISCOVERY

which most appeals to Mr Gardner, and in dealing with the invention from that point of view he said the standard of rubber qualities was fine Para hard cured, which consisted principally of caoutchouc, a substance bearing the chemical empirical formula $(C_{10} H_{16})_n$, with about 1·3 per cent. of resin, a little water —say, about 0·75 per cent.—from 3 to 4 per cent. of proteid, and yielding from 0·2 to 1 per cent. of ash. There was also colouring matter present and sometimes foreign impurities. Inferior rubbers might contain as low as 50 per cent. of caoutchouc. The presence of proteid matter in the latex might be shown by a very pretty test known as the xanthoproteic reaction. In this test nitric acid was added to the latex and the liquid was boiled, when it turned yellow, the change in colour being due to the formation of xanthoproteic acid. Ammonia added to the fluid caused it to become a rich orange. Rubber containing proteid, when diffused in chloroform, left an insoluble coagulum varying in amount with the quantity present; in other words, the proteids were nondiffusable. Those proteids were highly complex bodies which in the tree were built up from the simple chemical compounds acting as nutritive material to the tree. The particular kind of proteid in the latices of rubber-producing plants was an albumen coagulable by heat at 70 degrees. The coagulant invented by Mr Elias seemed to practically, if not altogether, eliminate the undesirable proteid. "For this reason," added Mr Gardner, "I believe this coagulant will produce

A REVOLUTIONARY EFFECT ON THE RUBBER WORLD."

The processes of coagulation could not be regarded as strictly scientific, Mr Gardner says, and, indeed, a great deal of waste often took place, with the frequent result that rubber was produced lacking the resiliency or even, at times, avoidable impurity. One advantage of the new coagulant was that no technical skill was required to use it. Its use, he believed, would result in an enormous saving of time and material. Its ready facility of transport would render it of great commercial value. Acetic acid and other forms of coagulants at present in use were very inconvenient to transfer across country in comparison with the new method, which was in powder form, and could be carried in a glass tube. Another point was that of a little of the powder or coagulant, added to the milk, effected complete coagulation in the space of a few minutes, and in bulk tho action was almost as quick. At present acetic acid took from eight to twenty-four hours to produce the same result. With this latter process, too, there was the danger that the use of insufficient acid would produce incomplete coagulation, and if too much were employed it would redissolve the proteids and retain them in the substance. The new method would also prove of value from the point of view of health saving. It was impossible to remove the latex any distance for even shaking in such climates would cause it to partially coagulate. The process, in any event, therefore, had to be conducted on the spot, and there was serious impairment to health among the native labourers who, at present, were obliged to remain in unhealthy marshy districts, whilst awaiting coagulation. The Elias coagulant, he believed, would be found to decrease the quantity of resin in the rubber, if it were carefully used, with the result that it would vulcanise much better; it would also tend to act as a preservative. Some of the powder had already been sent to Peru, the Congo, and other rubber-producing countries, and the samples he analysed were sent to him by a South American company which had adopted the new process.—*H. & C. Mail*, Sept. 10.

A NEW METHOD OF COAGULATING RUBBER LATEX.

A PRACTICAL DEMONSTRATION WITH "PURUB."

Invention of a German Expert.

Simplicity in the preparation of the latex of tho rubber tree into rubber itself for manufacturing purposes is a matter of the greatest importance to rubber planters and manufacturers. In Ceylon at present, as in most other parts of the world where rubber is grown, the most commonly used chemical for coagulating the latex is acetic acid. It is most important in treating latex that the natural moisture in it should be preserved and the one great disadvantage of using acetic acid is that after the latex has coagulated the rubber must be thoroughly dried before it can be fit for shipping which

detracts from its "nerve" and elasticity and consequently lowers its value in the market. A chemical has now been discovered to take the place of acetic acid. The discoverer of the new process is Mr D Sandmann, of Berlin, a Judge of the Arbitration Court in that city and a member of the Municipal Council and Chamberof Commerce of Berlin. Mr. Sandmann is at present in Ceylon on his way to Germany after a lengthy tour, and this morning (September 21st) he gave

A DEMONSTRATION OF HIS METHODS

of coagulating latex at the Henaratgoda Gardens. The demonstration was made in the presence of Mr. M. Kelway Bamber (Government Analyst), Mr. M. Hohl (Manager of the Manure Department of Messrs. Freudenberg & Co.), and two representatives of the press. Mr. Sandmann calls his invention "Purub," a curtailment of the words "pure rubber." According to him it is a preparation of *fluor*, a well enough known chemical. The preparation itself is of course the secret of Mr Sandmann and the Company to which he has sold his patent rights. The demonstration was held in the little laboratory in the Gardens and was conducted after the following manner:—Half a litre of latex (1/9th of a gallon) extracted from trees in the Gardens were poured into three chemical basins, the exact proportions being 440 C. C. latex and 1,320 C. C. water. Into one of these was added the usual quantity of acetic acid, 30 C. C. diluted in water—1 in 80. Into the other two were added ½ a gramme of 'Purub.' The basins were covered and after an interval when the covers were taken off the latex treated with 'Purub' was found to have nicely coagulated, while the latex treated with the acetic acid had, of course, not completed the coagulation stage. Mr Sandmann claims for 'Purub' that it stops the decomposition of the rubber from the moment it comes in contact with the latex and that it preserves its moisture, enabling it to be shipped with 9 to 10 per cent of moisture; whereas when acetic acid is used, the rubber only retains about 1 per cent of moisture by the time it is dry enough for shipping and if it is shipped before it is quite dry it gets mouldy and tacky. In any case the almost total absence of moisture

REDUCES THE VALUE OF RUBBER

considerably from the manufacturer's point of view, while the presence of it to the amount of 9 to 10 per cent rendered possible, according to Mr Sandmann, by the use of "Purub," increases the commercial value of the rubber correspondingly. The great advantage of "Purub" over acetic acid, says the inventor, is that it immediately stops putrefaction which sets in as soon as the latex leaves the trees. When acetic acid is used, the putrefaction continues until the rubber has been thoroughly dried by which process the rubber loses its elasticity and a great deal of its commercial value. By using "Purub" the rubber can be shipped when it is only partially dry and with a percentage of moisture in it that keeps it in splendid marketable condition. A small quantity is sufficient to coagulate a large quantity of latex, the proper proportion being two grammes to a litre of latex. It will be found a little more expensive than acetic acid, but according to Mr Sandmann, its use is bound to result profitably to the grower. To his own knowledge rubber treated with "Purub" and exported from East Africa fetched 20 per cent better prices in the London market than rubber treated without it. The use of "Purub" was as beneficial in the case of castilloa and ceara as in that of para. The demonstration concluded about 12·30. The latex treated with "Purub" had coagulated in an hour and the biscuits were taken out of the basin to dry. It will be treated in the ordinary way and will then be tested with a view to finding out the real effects of the "Purub" treatment.

MR. BAMBER'S OPINION.

Mr Bamber, asked by our representative for his opinion on the morning's demonstration, said the latex coagulated quickly, but nothing else could be said until the rubber became dry and was vulcanised. They themselves (meaning the Government Scientific Department) were carrying on heaps of experiments, but they could not yet express an opinion on any one of them. He was personally of opinion that rubber should retain 9 or 10 per cent of moisture, but whether it would increase the commercial value of it depended on the manufacturers. Would they pay anything more for it? A large quantity of such rubber remained unsold in London.

THE TREATMENT OF LATEX.

After the experiments were set in train and while waiting for the first definite results, Mr Bamber took Mr Sandmann and party to a section of old rubber where the Sinhalese tappers were tapping some of the trees. What attracted Mr Sandmann most was the bamboo stand for holding the cup, but he could not understand why it was that a piece of metal was used for running the latex from the bark into the cup and not a piece of bamboo or wood. He is against the use of metal in any connection with the receiving of the latex from the bark and its treatment afterwards. The cups, he thinks, should always be of porcelain or glass and the vessels of enamel. It was also of great importance that the latex should be kept cool when being conveyed from the tree to the store. The sun's rays had the effect of quickening the process of decomposition of the latex. A wet cloth over the vessel carrying it would prevent this and also keep it cool. It was also of the greatest importance that all the utensils used for the preparation of the rubber should be kept absolutely clean and to help towards this he strongly recommended that only wooden utensils, well-smoothed, should be used. With regard to sieves, in his opinion the best are those made with horse hair. They should be of two sizes, large and small, the former to be placed on top and the latter below. Another point was that the hand should not be brought in contact with the latex which becomes acidulated by such contact.

THE RUBBER TREES IN THE GARDENS.

There are some hoary old giants among the rubber trees in the Gardens, planted years and years ago. In the early days the evils of close planting were not realised. Some of the trees

were measured by Messrs Bamber and Sandmann. Two trees of the same age measured 93 and 133 inches in girth respectively, the difference being accounted for by the fact that the former was one of two closely planted trees. Mr Sandmann took several snapshots of the tappers at work.

The party returned to Colombo by the train leaving Henaratgoda at 1-55 p.m. Mr Sandmann leaves for Germany on the 25th inst.

CACAO IN JAMAICA.

It is conceded that not even with the exception of bananas and sugar, cocoa can be our most steadily profitable crop in suitable soils and climates here. As with other things, however, it seems that where cocoa grows most readily of itself it has been allowed to do so, and the owners have gone on the principle of taking what they got. There are some highly cultivated and well-regulated cultivations not in the best situations for cocoa growing, where good results are obtained, as well as the splendid results in typical good locations where care and thought and labour are expended on the plantation. Even in these places, however, the owers have many troubles with their trees, so that the same constant care and attention and never-ending watchfulness have to be kept up. What then must be the result where cocoa trees having grown strong and rampant for many years without any attention, without pruning to let light and air in, without drainage to carry off surplus moisture in wet weather, without the soil ever being broken, without rotten branches and diseased pods ever being cleared out of the way, until, the trees themselves are covered with moss and the soil is stiff and sour There are many places where this applies,—in S. Thomas-in-the-East and Portland, and Upper S. Andrew and S. Mary especially. Surely it would be a

GOOD POLICY TO CONCENTRATE ATTENTION IN GETTING ALL COCOA TREES HEALTHY

and brought into full bearing rather than getting the same owners to plant more cocoa in other parts of the same land. Of course if the owners of trees are hopeless, and do not see what is to their advantage, and there are other men who have not planted cocoa at all yet who wish to do so, and have a suitable location, it is good to encourage them, but with hotbeds of disease close by unattended to, the other plantations despite great care (which they will not always receive), will be attacked by and by when the trees begin to cover the ground, probably just when they are coming into full bearing.

A REGULAR CAMPAIGN AGAINST COCOA AND COCONUT DISEASES IS NECESSARY.

Amongst small settlers it is a rare thing to see cocoa trees that are bearing to anything like the full extent they are capable of. It is even more necessary than manuring, this question of getting the cocoa trees healthy first, but in S. Thomas-in-the-East and Portland, very little manuring requires to be done, it is aëration that is wanted most in the cocoa field.—*Journal of the Jamaica Agricultural Society* for July.

TO DESTROY WHITE ANTS.

A GERMAN APPARATUS.

We have received the following from a German firm which may interest some readers who have been complaining about damage done by white ants. In figuring with the fact that many agricultural undertakings suffer more or less from termites, so-called "white ants," I take the liberty of recommending my apparatus and preparation for their destruction. Firstly, I have constructed an apparatus the "termite finder," which makes it possible to locate the insects' nests. The "termite finder" is a steel pipe, at the top end of which is placed a microphone. This is further connected with a telephone by a cord. If the pipe is put in the earth, one will hear plainly the noise made by the so-called white ants in their subterranean habitations, even at great depths. If one wishes to seek termites near trees, all that is necessary is to put the end of the pipe against the tree. If one wants to locate a certain district, the best way is to have two labourers each with

A 'TERMITE-FINDER'

at distances of 5-6 metres. In this way, all the nesting places of the ants will be located. To smoke out the nest, the same must be bored with a simple "earth-borer" (a crow ?), 3½ feet long and 4 inches in diameter. Generally several nests are together and are connected by walks. In the hole bored one places a miniature oven "Pandora-box." The top of this oven must be just visible. Into this, air must be pumped to keep alive the cumbustion of a specially prepared mass contained therein and which generates smoke. Slowly and carefully a hand pump is to be used so that the oxygen reaches the fire and the poisonous gases from the mass are forced below through the air pressure. The preparation manufactured by me called "Smoke-snake," generates sulphuric acid. The prepared stuff is about one metre long and as thick as a finger, is rolled up, and fits into the "Pandora-box" after taking off two tops (coils). In this way they are carried easily even by domestic labour. The same manipulation is necessary for trees which have been attacked by termites and rendered hollow by them. The insects by breathing the poisonous gases die very soon. The holes naturally, which have been made on the living trees, would have to be stopped up with cement or clay. It is to be recommended that the above way of exterminating the termite is to be done frequently, regularly and systematically. The cost is not great comparing it with the damage done by the termites.—FRIEDRICH SUCK, Hamburg, 15 (Sachsenhof).—*Journal of the Jamaica Agricultural Society*, for July.

GROWTH OF PARA RUBBER IN SUMATRA.

A well grown Para rubber tree on Bandar Pinang Estate (owned by the Bandar Sumatra Rubber Co.), Sumatra, was planted in 1904 and at the time the photograph was taken (June 1909), it had attained a circumference of 38½ inches. The rubber, it will be seen, is interplanted with coffee. —*India-Rubber Journal*, Sept. 6.